San Diego
L.A. BASIN (West side)
Simi Valley
Ventura Basin
Pleistocene
Bay Point fm.
Palos Verdes and other terrace sands
Terrace material + Saugus fm.
Terrace material
Timm's Point (Siltstone)
San Pedro Sand
Las Posas fm.
Saugus formation
Lomita calcareous marl
?
Sweitzer fm.
?, or
San Diego formation
(Pico Formation missing) in Palos Verdes Hills - However 1500-2500 ss+sdy shl in basin to North + East
San Diego formation
Pico formation
Pliocene
Repetto Formation
unexpased
Repetto formation
"Santa Margarita" Shale
Malaga mudstone member
Bolivina obliqua
Modelo formation
Val monte diatomite mem.
Miocene
Monterey (Modelo) Shale
Altamira shale member
The San Diego fm rests unconformably on Eocene (Poway Conglomerate) and Pliocene rocks (unexposed)
Modelo Formation
Rincon
Vaqueros
Sespe
Oligo-Eocene
Sespe

	G H Eldridge & R Arnold 1907 (USGS Bull 309)	Kew 1924 (USGS Bull 753)	1932 16th Int Geol Cong.	Woodring 1937	Remarks
Pleistocene (lower)	Saugus	Terrace Deposits ~~Unconf~~	SAUGUS.	Saugus	equiv. to San Pedro Sds.
U	Fernando	Saugus	Pico	Pico	Upper Plio
M Pliocene		~~Unconf~~ Fernando Pico			
L			Repetto	Repetto	Lower Plio
Miocene	~~Unconf~~	~~Unconf~~			

S. A. Baer Ventura Basin

	North of Mt. Diablo	West of Mt. Diablo	Santa Cruz Mts.	Salinas valley district	Coalinga & north	McKittrick	SantaMaria
Tertiary	Martinez	Martinez	Butano ss.	Vaqueros Lincoln	Meganos	Meganos & Domengine	Meganos & Domengine
Chico	Marino Ponoche	none in Berkeley Hills Marino			Marino Ponoche	Chico Ponoche	San Luis Obispo Atascadero ss., sh.
	Horsetown (Ammonites)			No Cret accepted granite			
	Paskente (A.crass.)	Paskente (=Oakland conglom.)	Paskente		Paskente	Paskenta	San Luis Toro ss. possibly equiv. to Knoxville
	Lower Knoxville A. piochi	Knoxville	Knoxville	Coast Knoxville?			
	Franciscan	Franciscan	Franciscan and granites	Franciscan	Franciscan	Franciscan or granites or Cretaceous	Franciscan or granites or Cret.

Ventura district Santa Paula Newhall	L.A. to Santa Ana Mts.	Generalized section, Oregon, Wash. N.Calif. Coast Ranges	Santa Maria ~~U.S.~~ (inserted to place the above section) ~~section~~
Martinez	Martinez	Meganos	Meganos & Domengine
Sta. Inez mts. ~~Chico~~ Chico	Sta. Ana mts. Chico		Atascadero
?			Toro ss. sh. possibly Knoxville
?	Triassic, or granites		Franciscan or granites or Cretaceous

Goes on Bottom of Blue Print Chart

Geotimes March 1975 p. 23

Oldest known rock on earth

Gneiss in SW Minnesota dated

at 3.8 billion years BP by

rubidium - strontium &

uranium - lead method - USGS

Ulra 3:173 G. Radhakrishnan

Stock - Eoc, primates Calif.

(1) Sci (N.S.) 78: 524 1933

(2) Eoc Vert. [illegible] - Proc Geol Soc Amer 1934, 332 abst.

(3) " Titanothere San Diego Co, [illegible] of Poway conglom. Proc Nat. Acad. Sci 23: 46-53 1937

(4) Evidence of changing climates during Eoc & Oligo of Calif. Proc. Geol. Soc. Amer 1936, 300 (abst. (1937)

Vandenhoof 1935
seasonal banding in an asphalt dep. at Mex.
Proc. Geol. Soc. Amer. 1934: 332 abst. also in
Sci news letter 25, 243 (1935)

Permian

Romer 1937c pelycosaurs S.W.(U.S.),
Proc. New England Zool. Club 16: 89-96, 1 pl.,
abstract in Proc. Geol. Soc. Amer. 1936 p 378

Hesse & Weller 1934 - dinosaur, Calif. (Cret.)
Science n.s. 84 pp 157-158 also
Sci news letter 30, 137 & 32, 108

References for Calif Geology - from Reed, T from Camps.

Triassic

J.P. Smith "Upper Triassic Marine Invertebrate Fauna of N. Amer. USGS Prof. Paper 141 (1927) p. 3.

J.C. Merriam, "Triassic Ichthyosauria with special reference to the American forms."
U.C. Mem vol. 1, no. 1 (1908)

Jurassic

N.L. Taliaferro, "Geologic History and Structure of the Central Coast Ranges of California" Calif. State Div. of Mines Bull # 118 (1941) pp 119-167. Reports radiolaria, ichthyosaur skull fragments, ammonites & bits of wood in the Franciscan

W.M. Fontaine - Up Jurassic flora U.S. Geol. Survey Monog. 48, pp. 48-145 and

Cretaceous → Lower Cret. flora, U.S. Geol. Survey Monog. 48, pp. 211-217

J.P. Smith - The geologic formations of Calif. — State Min. Bur. Bull. 72 (1914) pp 33-37.

MANAGEMENT BOND
A HAMMERMILL PRODUCT

C 17 localities

San Francisquito Canyon &

Vasquez Canyon

Sources of Geologic Data

Calif. Inst. of Tech. Summer Camp, 1947
R.H. Johns
E.C. Simpson
R.C. White.

Modified from Map compiled by
William R. Muehlberger, November 1953

EXPLANATION

QUATERNARY — Recent

Qsl Alluvium

Qs Landslide materials

Qt Terrace deposits

TERTIARY — Pliocene — Late lower Miocene — Upper Miocene — Oligocene(?) — Paleocene

Ts Saugus formation (sands and gravels gray to brown, terrestrial)

Ta Anaverde formation (conglomerate arkose and shale, terrestrial)

Tm "Modelo, Castaic fm (sandstone and shale, brownish, marine)

Tmc — Tmcbc — Mint Canyon formation Tmc, sandstone and siltstone with minor conglomerate, undifferentiated; Tmcbc, basal schist-bearing conglomerate)

Ttc Tick Canyon formation (claystone, siltstone and sandstone, coarse basal conglomerate, reddish brown, terrestrial)

Tv — Tva — Tvv — Vasquez series (Tv, conglomerate, breccia and arkose, undifferentiated, gray to pink, terrestrial; Tva, conglomerate, clasts composed of anorthosite and related rocks; Tvv, andesite and basalt flows and shallow intrusive sheets)

Tmz — Tmzsh — Tmzss — Tmzcg — Martinez formation (Tmz, sandstone, shale and conglomerate, undifferentiated marine; Tmzsh, shale; Tmzss, sandstone; Tmzcg, conglomerate)

PRE-CRETACEOUS

gr Undifferentiated quartz-bearing igneous rocks (includes minor units of gneiss and schist)

qd Quartz diorite

gd Granodiorite (includes quartz diorite, quartz monzonite and minor dike rocks)

Sy Quartz syenite

di Diorite (includes minor units of granite)

an Anorthosite (includes minor amounts of diorite)

gn — gnm — Gneissic complex (gn, biotite schists injected by granite and diorite; gnm, zone of mafic gneiss)

ps — psl — psq — Pelona schist (ps, muscovite schist, chlorite muscovite schist and actinolite chlorite schist, undiffentiated; psl, unit of interbedded limestone and quartzite; psq, quartzite unit)

NOTE: AN UNCONFORMITY IS PRESENT BETWEEN EACH PAIR OF GEOLOGIC UNITS

C 17 localities

San Francisquito Canyon &
Vasquez Canyon

Mint Canyon area

Topographic Index Map
for the area shown on
the geologic map below.

Topography from the Humphreys and Saugus Quadrangles, surveyed by the U.S. Geological Survey.

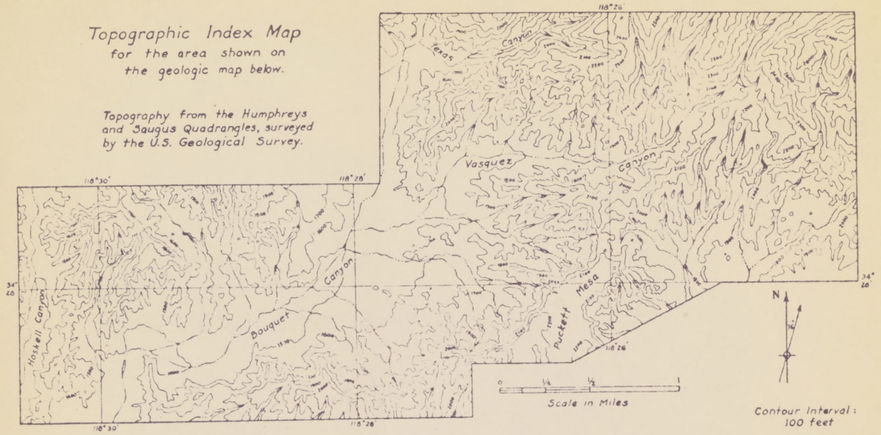

FIG. 4. Detailed geologic map of a part of the Mint Canyon area

Mint Canyon area

THE EARTH'S TIME TABLE

Astronomers have read into Earth's history some little variation from that aceepted by geologists. The following prepared by Harlow Shapley, Director of Harvard Observatory and his associates of research of Carnegie Institute follows ;

	Years ago
Origin of the Earth, Lifeless age -	3,000 Million
Life appeared in single celled forms	1,000 "
Age of Fishes began - - -	460 "
Age of Reptiles began - - -	240 "
Age of Mammals began - - -	65 "
Man-like Apes appeared - -	9 "
Pleistocene Men appeared - -	1 "

Age of Reason began with recent history.

The
GEOLOGICAL STRATA

WITH NOTES

AND

TIMETABLE

ARRANGEMENT AND PRINTING BY

HADLEY—MARSH

SECOND EDITION (REVISED) 1945

THE earth is about two billion years old. This is not a mere guess, but is the result of careful cumulative studies by many investigators working over a long period of years and along various lines of evidence. Of particular use are investigations of radioactive materials in the rocks of anaient age. Largely by the slow disintegration of radium and uranium into lead, we have extended our conceptions of geologic time to its present limits. Of the two billion years of earth history, only about one fourth of it, 500 million years, contains useful records of plants and animals that were of sufficient density and complexity to be preserved in the form of fossils.

DR. EDWIN H. COLBERT,
American Museum of Natural History,
Published in *Natural History*, June, 1945.

CENOZOIC

Recent
15,000 Years ago

Rise of World Civilization

Era of Mental Life

AGE OF MAN

Conch.—*Oliva, Murex, Cypraea, Conus.*

AGE OF MAMMALS

Pleistocene
or Glacial

1,500,000 Years ago

Periodic Glaciation

Modern Mammals

Emergence of man

Coneh.—*Harpa, Voluta, Tonna.*

Pliocene
15,000,000 Years ago

Development of Anthropoid Apes.
Modern Plants and Trees.

Conch.—*Fusus, Terebra, Haliotis.*

Miocene
30,000,000 Years ago

Continued Development of Mammals

Conch.—*Ostrea, Turritella, Pecten, Glandina.*

Continuation of Mountain Building in the West—North and South America.
Increase of Larger Land Mammals. Horse, Camel and Elephant. Whales and Sharks.

Oligocene
40,000,000 Years ago

Appearance of Higher Mammals

Conch.—*Polygyra, Helix, Pleurodonte, Acavus.*

Further Development of Mammals and Birds.

Eocene
Began 60,000,000 Years ago

Vanishing of Archaic Animals

Angiosperms or Flowering Plants

BUTTERFLIES, TERMITES AND FLEAS

Conch.—*Caricella, Venus, Auricula.*

Emergence of Modern Mammals and Birds.

MESOZOIC

Began 200 Million years ago.

AGE OF REPTILES

Cretaceous
120,000,000 Years ago

Extension of Gulf of Mexico to Arctic Oeean.

Great Volcanic disturbance in rock mountain regions, causing extinction of Dinosaurs.

Extreme Specialization of Reptiles

WASPS AND BEES

Conch.—*Belemnites, Exogyra, Ostrea, Gryphaea, Ammonites, Baculites.*

Rise of the Flowering Plants.

Extinction of great Reptiles at end of Cretaceous

Jurassic
Began 150,000,000 Years ago

Dinosaurs

Rise of archaic Mammals

First Birds (Archaeopteryx)

Flying Reptiles (Pterodactyls).

Ammonites and other Cephalopods Abundant

Age of cycads, conifers.

GRASSHOPPERS AND FLIES. TRUE DRAGON FLIES. BUGS, MOTHS.

Conch.—*Belemnites, Ammonites, Unio, Inoceramus.*

Note—No break between this epoch and the preceding one in general Nature of flora. Both are called the age of Cycads.

Triassic
Began 200,000,000 Years ago

Earliest Mammal-like Reptiles (Microlestes)

Appearance of Dinosaurs
First great spread of Ammonites
Modern Corals

Conch.—*Aulacoceras, Ammonites.*

Plants represented by Rushes, Ferns, Araucaria, Conifers

Taxaceae, Ginkoales, Bennettales Cycadales

BEETLES AND DOBSON FLIES

PALEOZOIC

Permian
Began 225,000,000 Years ago

AGE OF AMPHIBIANS

MANTIDS, MAYFLIES, STONE FLIES.

Conch.—*Ammonites, Myalina.*

1 Family of Trilobites only survived.

Primitive Reptiles.

Glossopteris flora in S. hemisphere.
Little change in Carb. flora in N. hemisphere

Pennsylvanian
270,000,000 Years ago

UPPER CARBONIFEROUS

COCKROACHES, ANCESTRAL DRAGONFLIES

Conch.—*Pecten, Awuptygma, Ammonites, Bellerophon*

(*See Penn. on back*)

Early Amphibians.
Great Coal Forests—Europe and America.

Mississippian
Began 300,000,000 Years ago

SUB-CARBONIFEROUS

Pteredospermophyta, Seed Ferns.

Age of Seed Ferns.

Conch,—*Straparollus, Ammonites.*

Crinoids in abundance.
Wide Distribution of Coal Plants.

Devonian
345,000,000 Years ago

AGE OF FISHES

ANCESTRAL INSECTS.

Conch.—*Ammonits, Platycereas, Spirifera.*

First Amphibians. Abundance of Ganoid Fishes and Trilobites. Earliest Forests of Lepidodendron.

Silurian
375,000,000 Years ago

First traces of Land Plants, Club Mosses.

Conch.—*Orthoceras, Tentaculites.*

Mountain Building. Coral Reefs.

PALEOZOIC--Continued

Ordovician
435,000,000 Years ago

Conch.—*Maclurites, Cyclonema, Subulites, Lophospira*

Algal Floras

Abundant Pelecypods.
First Vertebrates — Fishes and Ostrocoderms. Abundant Gastropods, Cephalopods. First Corals, Bryozoans,

Cambrian
540,000,000 Years ago

First Trilobites in the Lower Cambrian

Conch.—*Hypolithes, Scenella, Volborthella, Salpingostoma.*

Cryptozoans (Calcareous Algae). Annelid Worms. Shrimp-like Crustaceans. Invertebrates in abundance. First Brachiopods.

Proterozoic
1 Billion Years ago

Glaciation in Huronian Region
Soft-bodied Invertebrates—Fossils Rare.
Sponge Spicules. Worm Casts.
Much Volcanic Activity. Sedimentation and Erosion.
Bacteria—some Algae

Archeozoic
1½ Billion Years ago

Graphite Deposits, probably derived from plants.
Igneous Activity. Sediments and Erosion.

Note—Most careful estimates show that life has existed on earth more than 70,000 times as long as recorded history. —Dr. Edwin H. Colbert, American Museum of Natural History,

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CENOZOIC

Recent

Plant life existing today has developed from the Pleistocene flora 90% of the plants now living in the area covered by the ice, and were in existence throughout all of the Pleistocene time.

Pleistocene

The Great Ice Age forced a further southward migration of plants. Some were left stranded on mountain tops. The long continuous mountain ranges from north to south in our hemisphere provided a refuge for many species, with lots of the boreal and arctic floras surviving.

Pliocene

Climate of the Northern hemisphere now undergoing gradual refrigeration, resulting in the richer and more delicate forms of vegetation to be chilled to death or obliged to move farther South.

Miocene

Palms are scarce and few conifers are present. Dicotyledonous trees dominant. Monocotyledonous represented by marsh and water plants. Miocene plants indicate tropical and subtropical conditions, somewhat like that of warm temperate North America.

Oligocene

Plants were such as now inhabit warm-temperate and sub-tropical regions. A tiny floating water-fern, Azolla, was found here. Pinus succinifer, one of the trees producing such great quantities of amber, became extinct.

Eocene

Plant types set in the Upper Cretaceous are continued. Cycads are rare and Conifers are losing the predominance they held in the Mesozoic.

MESOZOIC

Cretaceous

A new era of plant life begins here. In place of the Ferns, Cycads and Conifers of earlier Mesozoic deposits now are found large numbers of true Angiospermous Exogens, many belonging to existing types, along with various Monocotyledonous plants including the first samples of Palms. It is called the Age of Flowering Plants.

Ferns, Cycads and Conifers, resembling those of the Jurassic Period. Angiospermatophyta poorly represented, Taxales, Sequoias

Jurassic

Cycadophyta, Diatoms, Sequoias, Junipers and Arbor Vitae (doubtfully), Marattiaceae, Conifers allied to the existing Araucariae.

Triassic

Ferns, Conifers and Cycadophyta, Bennettitales. It is called the Age of Cycads. The Lepidodendroids, Asterophylites and Annulariae of Coal and Permian formations have disappeared.

PALEOZOIC

Permian

Coniferophyta numerous; conifers with true cones found here ; Ferns and Tree Ferns abundant ; Cycads doubtfully represented in single genus, Naeggerathia.

Pennsylvanian

Coniferophyta (Ginkgo). Glossopteris Floras, Equisetales, Sphenophyllales, Lycopodiales, Calamites very common, Lepidodendroids, Sigillarioides.

Mississippian

Pteridospermophyta (seed ferns) occurred also in late Devonian. Coniferophyta (Cordaites.)

Devonian

Early Land Flora (Psilophytalean Flora.) Pteridophyta, Arthrophyta (Calamites. Lepidophyta (Giant Club Mosses).

Silurian

First traces of Land Plants Lepidodendron (Club Mosses).

Ordovician

Algal Floras.

Cambrian

Calcareous Algae at various horizons.

Pre-Cambrian

Bacteria, some algae.

Data furnished by the Division of Entomology, Los Angeles County Museum, through the courtesy of Dr. John A. Comstock.

Data furnished herewith, on Conchology, by Dr. Howard R. Hill, Los Angeles Co. Museum.

Botanical data furnished by Miss Bonnie Templeton, Botanical Division, Los Angeles Co. Museum.

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	Land Life	Marine Life	Climate and topography
CRETACEOUS 125,000,000 years ago Dinosaurs abundant First Angiosperms	One duckbill dinosaur found in deposits of uplland sea in San Joaquin Valley	Marine reptiles (plesiosaur and mosasaur) and abundant minute forms (diatoms and foramś) in land sea in San Joaquin Velley. Marine fauna with ammonites and bivalves and univalve. abundant in Sta. Monica and Sta. Ana Mts., Shasta Co. and Coast Ranges.	
JURASSIC 165,000,000 years ago First birds Dinosaurs abundant Coniferous plants	Horsetails, ferns, cycads and conifers in Northern Coast Ranges		
TRIASSIC 200,000,000 years ago First dinosaurs First mammals	No land-laid deposits yet found in Calif.	Many ammonites; a few nautiloids and belmnoids coral reefs, mollusks Ichthyosaurs abundant in northern Calif. (Reading) Another sea lizard, peculiar to Calif., Thalattosaur, in Shasta Co.	Northeastern and southern Calif. under sea. Climate warm, possibly tropical. In the Los Angeles area, rocks of this age only in bordering mountains, Sta. Monicas and Sta. Anas.

PALEOZOIC ERA

GEOLOGIC PERIODS Age in years Key life forms (world)	LAND LIFE	MARINE LIFE	TOPOGRAPHY AND CLIMATE
PERMIAN 230,000,000 years ago Reptiles abundant	NONE	Trilobites Lorans what else? where? Sea life like that of Siberia	Inland sea gradually receded, land rose; period of volcanic activity. Climate cooler and drier. Seasons better defined
CARBONIFEROUS Pennsylvanian and Missippian 290,000,000 years ago Amphibians abundant First reptiles	NONE	Relationship to north Asia still obvious. Crinoids, corals, brachiopods (no vertebrates) where	Inland ~~sea~~ extended into region now occupied by Coast Ranges. Continental shelf still a land mass. Claimate warm & humid in most of America possibly cooler on west coast. No evidence of swamp lands which were present farther east
DEVONIAN 330,000,000 years ago First amphibians Fishes dominant	NONE	Only invertebrates record in California: brachiopod corals, worms, mollusks. Show relationship to Eurasian forms (sea connection across Siberia) where	Inland sea more northerly in extent than before Climates vary throughout the world; probably mild in California
SILURIAN 360,000,000 years ago First land life	NONE	Poorly represented in California where? what?	Inland sea including east edge of California still persists. Climate mild for most of this period.
ORDOVICIAN 420,000,000 years ago Marine life	NONE	Brachiopods, mollusks, sponges Inyo, Panamint & Telescope mountains & Nopah Hills near Shoshone, (from Camp)	Inland sea east of California and including easterly edge of center of state. Mild climate
CAMBRIAN 500,000,000 years ago Marine life only	NONE	Trilobites, brachiopods sponges, cystoids, and a few mollusks in deposits in Mohave Desert and	~~Coastal area a land mass~~ ~~East-central~~ California under water; ~~south to San Bernardino Mts.~~ Possibly some igneous & metamorphic rocks of this Era in Sta. Monica Mts.
PRECAMBRIAN TIME	In California Pre-cambrian granites, metamorphics and sedimentaris are known only in the Mohave desert and		

American + European correlations

Recent
(Holocene)
(Psychozoic)

Pleistocene
  Middle Quaternary
    Wurmian (glacial)
    Chellian
    Rissian (glacial)
  Lower Quaternary
    Cromerian
    Mindelian (glacial) or Sicilian — from the Sicilian* down is included in the Pliocene by some authors.
    St. Prestian
    Villafranchian (Calabrian), or Gunzian? (glacial)

Pliocene
  Sicilian* (upper)
  Astian (middle)
  Plaisancian (lower)

Neogene usually includes Pliocene and Miocene, but some authors extend it to include the Pleistocene, too.

Miocene
  Pontian or Sahelian (upper)
  Sarmatian ( )
  Vindobonian (middle
    Tortonian
    Helvetian
  Burdigalian (Langhian) (lower)
  Aquitanian* this is put in the upper part Oligocene by some

Oligocene
  Stampian (Rupelian) (some precede this by Chattian)) Upper Numulitic
  Tongrian (Eur. also where Ludian is called Eocene) and follow it by Lattorfian) or Tongrian Oligocene
  Ludian (Priabonian?) (lower) most authors place this at top of Eocene
  Bartonian — others call it middle Nummulitic or
  Auversian and Lutetian — Parisian Eocene)

Eocene
  Bartonian
  Lutetian
  Ypresian — From Ypresian down is Paleocene
  Londinian
    Sparnacian
    Thanetian
  Montian — SOme put the Montian in Upper Cretaceous

Cretaceous
  Upper Cretaceous (Senonian (Gulf series of U.S. (southwest)
    Danian — Laramian
    Maestrichtian
    Campanian — Montanan
    Santonian
    Coniacian — Coloradoan
    Turonian
  Lower Cretaceous or Comanchean or Shastan
    Cenomanian (sometimes placed in Upper Cret.)
    Albian (same as Gault)(sometimes included in Up. Cret.
    Aptian (includes Gargasian and Bedoulian) same as Lower Greensand)
    Barremian (or Urogonian
    Hauterivian
    Valanginian (includes Berriasian) } 2 together sometimes called Neocomian

Jurassic
  Upper Jurassic (Malm), Mid. Jur. or Dogger, Low Jur. or Lias
  or divided into Oolithic subsystem with 7 divisions and
                  Liassic subsystem with 8 divisions

Triassic
  Upper or Keuper
   may be divided into Rhaetic, Noric and Karnic
  Middle or Muschelkalk
   divided into Ladinic and Anisic or Ladinian and Virglorian
  Lower or Bunt sandstone, also called Wurfenian

Quarterly Journal
Geological Society of London
Vol. 32 — 1876

Article by H. G. Seeley
"On the British forest cretaceous
birds" pp. 496-512, pls. 26-28.

Proc. U S Nat Mus

26 – pp 553-555

type > -8

Pleistocene

Procellariiformes	Pelecaniformes	Ciconiiformes	Anseriformes
		Ardeidae	
Puffinus yeyermanni	Pelecanus grandicaps	Ardea palaeoccidentalis	Biziura exhumata
	" pervagus	" megacephala	Nyroca robusta
		Butoroides mauritianus	" reclusa
	Australoconax gregorii	—	" effodiata
		ciconiidae	
	" vetustus	Prospelargus nobilis	Nettapus eyrensis
	Phalacrocorax idahensis	Palaeciconia australis	Anas gracilipes
	Phal. macropus	Ciconia maltha	
	" pamphaeanus	Xenorhynchus ranus	
	—	Xenorhynchopsis tibialis	
	Anhingidae	" minor	
	Plotus parvus	Jabiru weillsi	
	" laticeps	—	
	" ranus	Threskiornithidae	
		Ibis coronatus	
		Platalea subtenuis	
		—	
		Phoenicopteridae	
		P. copei	

Apterygiformes	Tinamiformes	Sphenisciformes	Colymbiformes	Gaviiformes
Metapteryx bifrons	Nothura palustosa		Podilymbus magnus Colymbus parvus	Gavia pusilla

X = still living species

Pleistocene

Pleistocene

Struthioniformes	Rheiformes	Casuariiformes	Dinornithiformes	Aepyornithiformes
Struthio camelus	Rhea nana	Casuarius lydekkeri	Dinornis gigantea	Aepyornis maximus
" andersoni	Rhea americana X		" maximus	" medius
" chersonensis		Dromaeus patricius	" inermis	" gracilis
" mongolicus		" gracilipes	" novaezealandiae	" hildebrandti
" sp.		" queenslandiae	" dromioides	Mullerornis betsileï
		" minor		" rudis
		Dromornis australis	Megalapteryx didinus	" agilis
		Genyornis newtoni	" hectori	
			Anomalopteryx didiformis	
			" parvus	
			" curtus	
			" oweni	
			Emeus crassus	
			" casuarinus	
			" huttoni	
			" exilis	
			Euryapteryx elephantopus	
			" gravipes	
			" cursor	
			" pygmaeus	

Pliocene

Procellariiformes	Pelecaniformes	Ciconiiformes	Anseriformes
		ciconiidae	
Diomedea anglica	Pelecanus sivalensis	Ciconia gaudryi	Fuligula aretina
	" odessanus	Leptoptilus falconeri	" sepulta
			Anas lignitifila
			" eppelsheimensis
	Paracoracias stefanii		
	Plotus pannonicus		

Pliocene 2

Tinamiformes

Tinamisornis parvulus
" intermedius
~~Nothura paludosa~~

Columbiformes Gaviiformes

Columbus portisi
Podiceps pisanus

Pliocene

Struthionithes	Rheiformes
Struthio wimani	Heterorhea dabbenei
" karatheodoris	[illegible]
" novorossicus	
" asiaticus	

Miocene

There is usp age one of the Miocene (no ostriches – aepyornithiformes)

Aptenygiformes	Tinamiformes	Sphenisciformes 1	2
		Palaeospheniscus patagonicus	Isotremornis notodenoskjöldi
		" mengbieri	Parasphenodytes antarcticus
		" interruptus	Arthrodytes grandis
		" robustus	" andrewsi
		" medianus	Anthropornis notodenoskjöldi
		" planus	Pachypteryx grandis
		" rothi	Anthropteryx gigas
		" intermedius	Palaeeudyptes antarcticus
		" affinis	Pachydyptes ponderosus
		Parasphenicus berzi	" novaezealandiae
		" nereus	
		Perispheniscus wimani	
		Palaeospheniscus ictus	
		Argyrodyptes microtarsus	
		Pseudospheniscus interplanus	
		" concavus	
		Delphinornis larseni	
		Neculus rothi	
		Icthyopteryx gracilis	
		Metancylornis curtus	
		Eospheniscus gunnari	

Miocene

Procellariiformes	Pelecaniformes	Ciconiiformes	Anseriiformes
		Ardeidae	
Plotornis delfortrii	Pelecanus intermedius	Ardea aurelianensis	Conornis australis
Puffinus diatomicus	" fraasi	" brunhuberi	Eudelornis patagonica
" conradi	Cyphornis magnus	" perplexa	
" inceptor	Palaeochenoides miocaenus	" lignitum	Anas blanchardi (also oligo)
Procellaria aquitanica	—	Ardeacites molassicus	Anas consobrina (also oligo)
" antiqua	Pelagornis miocaenus	Botaurites avitus	" sansaniensis
	Tiphornis heterornus	" similis	" velox
		=	" robusta
	Sula pygmaea		" nisoriensis
	Sula vollelti	ciconiidae	" meyeri
	" lompicana	Propelargus edwardsi	" basaltica
		Pseudotantalus melitensis edwardsi	" skalicensis
	Miocula media	—	" isarensis
	Morisloxostyla	Threskiornithidae	
	" vagabundus	Ibis pagana (also oligo)	
	—	Protibis cremiculis	
		=	
	Oligocrax littoralis (also olig)	Phoenicopteridae also oligo	
	Miocrax femoralis	Palaelodus ambiguus	
	" intermedius	" minutus (also oligo)	
	" praecanbo	" Steinheimensis	
		Elornis littoralis	

Oligocene

apterygiformes	Tinamiformes	sphenisciformes	Colymbiformes	gaviiformes
		Palaeosphenicus gracilis	Colymbus oligocaenus	Colymboides minutus
		Cladornis pachypus		Col
		Cruschedula revola		

Oligocene

Struthioniformes × Rheiformes × casuariiformes × Dromaiiformes × Aepyornithiformes

Stromeria fajumensis
Eremopezus eocaenus

Oligocene

Procellariiformes	Pelecaniformes	Ciconiiformes	Anseriformes
		Ardeidae	
Hydrocaio natator	Pelecanus gracilis	Goliatha andrewsi	Laornis clivus
Puffinus arvernensis	~~Pelecanus~~	Prardea amissa	
	Sula ronzoni	~~Ardea famosa~~ Propelargus	Fuligula arvernensis
	" arvernensis	Propelargus cadurcensis	
		Pelargodes magna	Anas crassa
	Oligocorax littoralis (also in Phoenicopteridae)	" stehlini	" macroptera
	" mivaensis	" franconardi	" blanchardi (also mio)
	" marinavis	Amphipelargus major	" consobrina (also mio)
	" mediterraneus	Palaeoephippiorhynchus diastatus	" natator
		Leptoptilus arvernensis	" Benedeni
		Threskiornithidae	
		Ibis pagana (also mio)	
		Tridopodia paludosa	
		Phoenicopteridae	
		Palaelodus ambiguus (also mio)	
		" crassipes	
		" goliath	
		" minutus (also mio)	
		Elornis grandis	
		Phoenicopterus croizeti	

Eocene 2

Colymbiformes . Gaviiformes

Colymboides anglicus

Eocene

Struthioniformes | Rheiformes | Casuariiformes | Dromaiiformes | Aepyornithiformes

Psammornis lybicus
" rothschildi

Eocene birds

	amer. So	amer. N.	France	England	Belg.	Africa	Sumatra
Colymbiformes							
Enaliornithidae							
Neogaeornis	✓						
Empheranis			✓				
Colymbidae							
Colymboides				✓			
Procellariiformes							
Gigantornis						✓?	
Diomedeidae							
Prophaethon				✓			
Pelecanidae							
Protopelecanus			✓?		✓		
Argillornis				✓			
Odontopteryx					✓		
Eostega					✓		
Anhinga							
Prosoplotus							✓
Odontopterygidae				✓			
Odontopteryx							

	Cret	Eo	Oligo	Mio	Plio	Pleist	Rec.
Struthioniformes					✓		
Rheiformes					✓	✓	
Casuariformes						✓	
Apterygiformes						✓	
Tinamiformes					✓	✓	
Gheniciformes				✓	✓		
Gaviiformes		?	✓		✓	X	
Colymbiformes		E	X			X	
Procellariiformes		Africa	E	XE	E	XE	
Pelecaniformes		XE	XE	XE	XE	XE	
Ciconiiformes		XE	E	E	E	XE	
Anseriformes		E	E	XE	XE	XE	
Falconiformes		E (vulture) Eocene	XE	XE	XE	XE	
Galliformes		XE	XE	XE	XE	EX	one in Australia Pleist. many Pleist.
Gruiformes		XE	XE	XE	XE	XE	
Charadriiformes		XE	X?E	XE	XE	XE	
Columbiformes		E	E		X	XE	
Psittaciformes			E	X			
Cuculiformes			E	E		X	
Strigiformes		X	E	E		XE	

	Cret	Eo	Olig.	Mio	Plio	Pleist	Rec
Caprimulgiformes		none fossil					
Micropodiformes		E	E	E			
Coliiformes		E	none				
Trogoniformes		E	E (one sp. only)				
Coraciiformes		E	(Germany)				
Piciformes		from E	E	E		X	
Passeriformes		E	E	XE	E	XE	

Sternum keeled or unkeeled. pelvis bones connected or not

Skull toothed or not

Position of coracoid & scap.

	absent	unkeeled	keeled	teeth	no teeth	Coracoid & scap. continuous parallel	Coracoid & scap. continuous angle	pelvis connected	pelvis not	Jurassic	Cret	Eo	Oligo	Mio	Plio	Pleist
Archaeopteryx	✓			✓					✓	X						
Struthionidae		✓ 2 toes			✓	✓										
Rheidae		✓			✓	✓										
Casuariidae		✓			✓	✓										
Dinornithids		✓			✓	✓			✓							
Aepyornithids		✓			✓	✓			✓							
Apteryxids																
Tinamidae	✓		✓		✓		✓	fibrous cartilage								
Spheniscidae			✓		✓		✓	✓								
Aepyornithid		✓		✓			✓		✓		X					
Dromaeornithids			✓				✓		✓							
Apatornis							✓		✓							
Pradavidae			sternum only element known									X				
Gastornis												X				
Argillornis				?												

see Lydekker 47-50, C.F.B Fig. 1 p. 59

FLIGHTLESS BIRDS

1 Ostrich -- Struthio camelus
Africa

2 Rhea -- Rhea americana (and Pterocnemia pennata?)
Brazil, Uruguay, Argentina, Peru, Bolivia, Chile

3 4 Cassowary -- Casuarius casuarius
" bicarunculatus
" bennetti
" unappendiculatus
" hagenbecki
" jamrachi
New Guinea and adjacent islands

2 1 Emu -- Dromiceius novaehollandiae
Australia (also an extinct sp. from Australia, and 1 from Tasmania)

*Moas -- Dinornis, Megalapteryx, Anomalopteryx, Emeus, Eurapteryx
(5 genera and 22 species)
New Zealand up to about 200-300 years ago

3 Kiwi -- Apteryx australis, A. oweni, and A. hastii
New Zealand

*Aepyornis -- Aepyornis, several species
Madagascar (with ancestors back to the Oligocene of Fayum)

17 Penguins -- Aptenodytes, Pygoscelis, Eudyptes, Megadyptes, Eudyptula, Spheniscus
Antarctica, New Zealand, Tasmania, So. America, Galapagos, islands of Africa (so.)

— 1 Harris' Cormorant Nannopterum harrisi
Galapagos Islands

— 1 Auckland Island Duck -- Nesonetta aucklandica
Auckland Islands, N.Z. (not completely flightless, fly short distances, reach nests in cliffs thus)

— 1 Steamer Duck -- Tachyeres brachyptera
Falkland Islands, and coasts of so. South America, and Andean Lakes
(flies when young, body size outgrows wing ability, however)

Domestic Chicken -- Fluttering flight only
Domestic Turkey

2 Woodhen (Weka) -- Gallirallus australis, G. troglodytes
New Zealand (and 1 extinct)

*Chatham Island Rail -- Diaphorapteryx hawkinsi (Forbes, Ibis 1893, p. 253)
Chatham Island (*Mauritius, Rodrigues Aphanapteryx related)

1 Takahe -- (Notornis hochstetteri) and extinct N. mantelli p.762)
some authorities say the same species (Forbes? Nature, 1923,
New Zealand (Proc. Zool. Lond. 1848, 1ff, Owen)

*Great Auk -- Pinguinus impennis
North Atlantic, Falkland Islands (s. to Fla. sometimes)

*Dodo -- Didus ineptus, D. borbonicus
Island of Mauritius and Reunion

*Solitaire -- Pezophaps solitaria
Island of Rodriguez

*Rail of St. Thomas and St. Croix islands -- Nesotrichis debooyi
(Wetmore, 1918, Proc. U.S.Nat. Mus. 54/516-519, pl.82)
" , 1922, Bull. Amer. Mus. Nat. Hist., 46, 307, fig.3-9)

from Newton - Dict. of Birds p. 109 et ad

Orders of carinates which are clearly distinct

Crypturi - Tinamous

Impennes - Penguins

Strigis - Owls (Picariae closest) - might have had affinities

Psittaci - Parrots

Passeres (or at least the Oscines - song birds)

Orders in which most members are clearly distinct but where there are a few "outliers" which are difficult to justify.

Pygopodes - grebes & loons [now separate order]

Gaviae - gulls: [Newton considers similarity between Limicolae, gulls & alcidae. Thinks they may have developed in that order - the alcidae being a degenerate branch of the gulls]

Limicolae - Newton suggests Limicolae, Gaviae & Alcidae as one family; includes Bustards who don't fit in Galliformes

Tubinares - Petrels, etc. [separate from gulls & a separate order than Newton]

Gallinae - true gallinae ~~etc~~ any ~~Hoatzin~~ Hoatzins but contain troublesome forms such as Hoatzin = Alectromantis [separate order]

~~Pteroclidae~~ Gallinae -

Columbae - [Pteroclidae or sand grouse - intermediate between Gallinae & Columbae. usually just with Columbae but they are precocious as in Gallinae]

Cuculi - (through screamers to herons)

Herodiones

Steganopodes

Accipitres (with Herons? Through Secretarius

Procellariiformes

EOCENE? -- AFRICA

Gigantornis Eaglesomei Andrews (Proc. Zool. Soc. Lond.1916, p.519) twice as big as an albatross. Thought to be Eocene; Ombialladistrict of SOUTHERN NIGERIA. Stands between the Tubinares and the Stegan opodes. femur (prox.) and tibia (dist.). Not assigned to family.

UPPER OLIGOCENE -- EUROPE

Hydrornis natator Milne-Edawrs p. 362, pl. 57
Upper Oligocene of Langy, Allier. Stands between Anseres and Tubinare, Tarsometatarsus, 32 mm. long. Procellariidae.

Puffinus arvernensis MilneEdwards p. 572. Upper Oligo, Langy and St. Gerand le Puy? Tarsometatarsus apparently a true puffinus

MIMCENE -- EUROPE and AMERICA

Plotornis Delfortrii MilneEdwards, 1878.
Middle Miocene Molasse Leognan bei Bordeaux, Tarsus and humerus frag. Placed in Procellariidae but description says similar to Diomedea. length of tarsus 70.5 mm.

Procellaria aquitanica MilneEdwards, 1874.
Middle Miocene Faluns de Saucats, Gironde. Humerus resembling Procellaria glacialoides (a Fulmar) and Puffinus Kuhlii (shearwater)

Procellaria antiqua MilneEdwards, 1874
Middle Miocene from same place as above of this genus. Humerus frag. Yet to be gone over. MilneEdwards gave no picture.

Puffinus conradi Marsh 1870.
Miocene (Calvert Formation) Maryland. Dist. humerus, dist. ulna. Appears very Puffinus like said to be Miocene ancestor of the stock that produced Puffinus gravis (accordijg to Wemore Auk1926p463 Wetmore believe the ulna is not of this species. [illegible]

Puffinus inceptor Wetmore 1930
Middle Miocene, Sharktooth Hill, Kern Co. Calif. Humerus dist. Like P. tenuirostris but smaller, larger than P. diatomicus, smaller than P. conradi and P. eyermani. Another humerus is mentioned but referred to Puffinus sp.

Fulmarus sp. (Wetmore 1926). Fragment of shaft of humerus
Miocene?, Chesapeake Beach, Maryland

Puffinus diatomicus Miller
Upper Middle Miocene. Lompoc, San Pedro and

Diomedea anglica separated from Puffinus of Florida (see Pliocene).

PLIOCENE -- EUROPE and AMERICA

Diomedea anglica Lydekker 1886 (see Miocene also)
Middle Pliocene, Red Crag, Foshall, Suffolk, England. Tarsus, and phalanx 1 dig. 4. Also an ulna.

Puffinus felthami Howard
Middle Pliocene Corona del Mar. Humerus and tarsometatarsus

Puffinus kanakoffi Howard
Middle Pliocene San Diego. Humerus and tarsus and?

Pelecaniformes

Family Phaetontidae EOCENE LONDON
Prophaeton Shrubsolei Andrews 1899
Mandible, femur, pelvis. Lower Eocene London Clay, Sheppey-is.
Was a good swimmer and diver resembling in structure and habit more Sula and Phalacrocorax than Phaeton. Prophaeton and Phaeton are placed as middle and terminal arms of this branch which branched off from the common stem of the Steganopodes perhaps at the beginning of the cretaceous (according to Andrews)

Family Pelecanidae ASIA(Plio)EUROPE (Eoc.-) AMERICA (Up.Plio)
Protopelecanus sp. Reichenbach 1851.
Upper Eocene of Montmartre Scapula frag. and complete femur.
Also frag. from Susswasserkalk von Mombach im Mainzer Becken thought to belong here.

Pelecanus gracilis Milne Edwards, p250 pl. 28
Upper Oligocene Labeur (in Vaumas); Langy; St. Gerand le Puy, Munchner aus Montaigut. Tarsus, Furcula, Humerus, femur.
More slender than modern forms.

Pelecanus intermedius O. Fraas 1870
Upper Miocene, Steinheim and Hahnenberg. Many parts of skeleton

Pelecanus Fraasi Lydekker 1891
Upper Miocene, Klein-Dorheim and Hahnenberg, Lierheim, Bayern.
Cranium, vertebra, femur

Pelecanus sp. Lydekker 1891 cranium from Up. Mioc. Steinheim.
Thinks it stands between intermedius and fraasi.

Pelecanus halieus Wetmore 1933.
Up. Plio Hagerman, Idaho.

Pelecanus erhthrorhynchus? L. Miller 1944.
Pliocene Dry Creek Oregon, 3 femora
Also known from Pleistocene Oregon, Calif. Nevada

Pelecanus sivalensis Davies 1880
Ulna and radius Lower Pliocene Sivalik-Hugel, India

Pelecanus cautleyi Davies 1880
ulna, femur. Lower Plio from same place as above

Pelecanus odessanus Wildhalm 1886
Lower Pliocene (Pikermi fauna, Odessa; Cora. tarsus

Family Cyphornithidae AMERICA Miocene
Cyphornis magnus Cope 1894. Tarsus, Miocene? vancouver Island
Twice the size of the largest pelican. Possibly resembles Sulidae.

Palaeochenoides miocaenus Shufeldt 1916.
Miocene, South Carolina. Femur
Wetmore says of these two forms that they are pelican-like but show distant relations ip with the Phalacrocoracidae, Sulidae and Anhingidae. Suggests ancient relationships of pelicans to gannets and more remotely to cormorant-anhinga branch

Family Sulidae [EOC. EUROPE) MIO SAMER

Superfamily Sulides, Family ?

Pelagornis miocaenus Lartet 1857
Resembles Sula in some characters, Pelecanus in others. Humerus
Lambrecht says also resembels Phalacrocorax. Humerus, Up. Mio. Armagnac,
and Middle Miocene Leognan in Bordeaux.

Argillornis longipennis Owen 1878.
Variously placed with ratites, Diomedea and, finally, the Sulida.
Very large. Skull appears to have sockets for teeth. Humerus, ulna
and fragment of skull. Lower Eocene Sheppey island; Middle Eocene,
Brussels.

Liptornis hesternus Ameghino 1895
Miocene of Patagonia. Vertebra pelecan-like? Lambrecht places nearer
the Sulidae. (vert. 27 mm. long)

Family Sulidae EUROPE (Rup. Oligo.) / AMER Mio

Sula ronzoni (Gervais) 1851
Lower Oligocene, Frankreich. Pelvis

Sula arvernensis Milne-Edwards 1868
Upper Oligocene, Frankreich. Close to Moris bassana. Pelvis

Sula pygmaea Milne-Edwards 1874
Middle Miocene, Frankreich. Humerus 128 mm. long (smaller than bassana)

Sula willetti L. Miller 1925.
Upper Miocene, Lompoc, nearly complete skeletal impression.

Sula lompocana Miller 1925.
Up. Mio., Lompoc, keletal impression.
Sula Stocktoni and S. avita. Miocene Lomita and Maryland respectively.
Sula sp.
Upper Pliocene, Italy. Humerus
Miosula media Miller 1925
Up. Miocene, Lompoc
Relatively smaller wings and large legs. Between Sulids and Cormorants.
(more generalized type)

Miosula recentior Howard, 1948
Mid. Pliocene, San Diego. Miosula continued into Pliocene

Moris loxostyla (Cope) 1870
Miocene Maryland, coracoid and humerus; Miocene New Jersey. Coracoid.

Moris vagabundus Wetmoer 1930.
Miocene, Calif.

Moris reyana Howard
Pleistocene Del Rey. Brings Moris up almost to Recent here.

Family Elopterygidae
Elopteryx nopesai Andrews 1913. Femur and tibiotarsi
Cretaceous (Upper), Sieburgen. Pelican-size but related to cormorants

Eostega lebedinskyi Lambrecht 1928
Middle Eocene. Siebenburgen. Related to cormorants and sulids. Mandible

Actiornis anglicus Lydekker 1891.
Upper Eocene, Hampshire, England. Ulna near cormorants.

Strigiformes
Coprotrix amer
5 from Europe

Micropodiiformes
3

Trogoniformes
7 Quecetrac Trogon Europe

Coraciiformes
1 in Coraciidae

Piciformes
1

Passeriformes
2 anc. strata
1 Paridae
3 inc. sedis

Cypselomorphae
Cypselidae 1

Diatryma - head 17" long
6½ deep

Phorusrhacos 2' long skull
long sharp beak locking
depth of Diatryma however
carcass 5" across

Eocene Orders - 17 of mod - 27

Grebes + loons linked in colymbiformes
Europe

Procellariiformes ? a possible linking
form (Gigantornis) with Pelecaniformes
Africa

✓ Pelecaniformes
Europe Booby + cormorant links Eurtazia
Europe Anhingidae (albatross ? booby ?)
Cormorant
Africa Anhinga

✓ Ciconiiformes
Europe Plesiodontidae, Xenicibis, Remiornis
— ardeiformes — link-pose links

— Falconiformes
Eocathartes
Falconiformes + Strigiformes

✓ Galliformes
Ruffe bet, Megapodes + Cracidae
Early phasianids
" quails

✓ Gruiformes
Rail-gallinule links
coot
Early crane
Early Rail

✓ Charadriiformes
Avocet ? ancestor
gull-Europe ?
Auks
Columbiformes
2 Pteroclids

Family Phalacrocoracidae AMERICA (~~MIO~~ Olig); EUROPE (OLIGO) ASIA (PLIO) AUSTRALIA (PLEISTOC.)

Oligocorax littoralis (Milne-Edwards 1868
Up. Oliogcene, France. Lower Miocene Hafenbaus. Several elements
Very much like Phalacrocorax but Lambrecht bases genera on coracoids.

Oliogocorax miocaenus (Milne-Edwards) 1868
Up. Oligocene, France. Many elements. Very similar to Ph. carbo

Oligocorax marinavis (Shufeldt) 1915
Oligocene? (John Day), Oregon. Ulna, humeri, tarsi

Oligocorax mediterraneus Shufeldt 1915.
Oligocene (White River), Colorado. Metacarpus.

Miocorax femoralis Miller 1929
Miocene, Calabasas, Calif.

Miocorax intermedius (Milne-Edwards) 1868
Mid. Miocene, Faluns de Touraine . Humerus

Miocorax praecarbo (v.Ammon)1918.
Miocene (Up.) Regensburg.

Paracorax destefanii (Regalia) 1902
Up. Pliocene, Pisa. Several elements

Paracorax sp. (Lydekker) 1879 (first thought to belong to Phaeotontid)
Pliocene. (Low.) Siwalik Hills. India. Tarsus

Australocorax gregorii (DeVis)1906
Pleistocene, Australia. Also A. vetustus.

Phalacrocorax auritus
Mid Miocene, Florida. 2 tarsometatarsi

Phalacrocorax auritus.
Pliocene Oregon and Idaho

Phalacrocorax rogersi Howard
Pliocene, Santa Barbara.

Phalacrocorax kennelli Howard
Pliocene, San Diego.

Phalacrocorax macropus (Cope) 1878
Pleistocene, Oregon

Phalacrocorax pampeanus Moreno u. Mercerat 1891
Pleistocene Argentina

Family Anhingidae

Protoplotus beauforti Lambrecht 1931
Eocene?, West Sumatra. Fairly complete skeleton all together.
Appears to have been a better flyer than the modern anhingas.
Probably could have gone further inland for breeding but apparently
stayed near the sea -- note fish skleetons found with Protoplotas.

Plotus pannonicus Lambrecht 1916
Pliocene (Low.) Hungary. Represents the most northern record of anhinga

Plotus parvus, Plotus laticeps
Pleistocene Australia

Plotus nanus Pleistocene, Madagascar

Family Odontopterygidae (Suborder inc. sedis Odontopteryges)

Odontopteryx toliapica Owen 1873
Low Eocene, Sheppey Is., England. Skull, mandible, ulna, tarsus.

Pseudodontornis longirostris (SPulski) 1910
Skull, Brasil, age unknown. This and Odontopteryx have boney teeth on
jaws (not set in sockets)

CICONIIFORMES

Family Ardeidae AFRICA (L.Oligo); EUROPE L.EOCENE; AMER. (Eocene)

Goliathia andrewsi Lambrecht 1930
Low. Oligo, Fayum, Egypt.
Stands in the same position with respect to recent giant herons as Palaeoephippiorhynchus stands to recent giant storks.

Proardea amissa (Milne-Edwards) 1891
Lower Oligocene, south Frankreich. Tarsus
Resembles the egrets

Ardea formosa Milne-Edwards 1871
Up. Oligocene, Langy

Ardea aurelianensis Milne-Edwards 1871
Mid. Miocene, Daluna de Suevres. Humerus

Ardea brunhuberi v.Ammon 1921
Up. Miocene, Regansburg. Metacarpus.

Ardea perplexa Milne-Edwards 1871
Midl Miocene, Sansan. Humerus

Ardea lignitum Giebel 1860.
Tertiary, Thuringen. Femur

Ardeacites molassicus Haushalter 1855.
Low. Miocene. Allgau in Harbartshofen. Humerus
Compared with Botaurus stellaris

Botaurites avitus v.Ammon 1918.
Up. Miocene Regensburg. Vertebrae. Resembles Botaurus

Botaurites similis (O.Fraas) 1870
Up Miocene, Steinheim. Tibia. Closest to Botaurus and Nycticorax

Botauroides parvus Shufeldt 1915
Eocene, Wyoming. Tarsus. Smaller than Least Bittern. Neither a true heron nor a typical Bittern, but belongs with both.

Botaurus lentiginosus
Pleistocene, Fossil Lake

Eoceornis ardetta Shufeldt.
Eocene, Wyoming. Sternum showing crossed coracoidal grooves. Small.

Proherodius oweni Lydekker 1891
Low. Eocene, London. Sternum, Tarsus. Less equality in length of the three distal trochleae of the tarsus. Lydekker thinks it a separate family but Lambrecht doesn't.

AUSTRAL. (Pleisto)

Family Ciconiidae EUROPE (Low. Oligo.) AFRICA (Low. Oligo) AMER (Plio) ASIA (Plio)

✓ Propelargus cayluxensis Lydekker 1891
Low. Oligo. Bach. Clearly storklike.

✓ Propelargus edwardsi Lydekker 1891
Up. Oligocene, Allier. Several elements. Very stork-like

Palaeopelargus nobilis DeVis 1892.
Pleistocene, Queensland

✓ Pelargodes magna (Milne Edwards) 1868
Up. Oligocene, Allier. Tarsus, tibia, humerus (also S. Gerand le Puy (also mandible and scapula)
Hard to distinguish from Ciconia alba in mandible. Tarsus has relatively larger trochela III

✓ Pelargodes stehlini (Gaillard) 1908.
Low. Oligo. Phos von Quercy. Tarsus. Smaller than P. magna.

✓ Pelargodes trouessarti (Gaillard) 1908
Low. Oligo, Phos. von Quercy. Tarsus. Between other 2 in size.

✓ Amphipelargus majori Lydekker 1891
Low. Plio. Tibio. Samoa.

Ciconia maltha Miller 1910 ✓
Pleistocene, Calif. and Plio, Idaho. (miller 1974 (L))

✓ Ciconia Gaudryi Lambrecht 1933
Low. Pliocene Pikermi. Humerus

✓ Pseudotantalus Milne-Edwardsi (Shufeldt) 1896
Up. Miocene, Grive St. Alban and Grotto Pietro Tamponi
Size of Tantalus loculator

Xenorhynchus nanas DE Vis 1888
Pleistocene Australia and two other species, same age, same genus

Palaeoephippiorhynchus dietrichi Lambrecht 1930
✓ Low. Oligo. No. Africa. Cranium and mandible. Ancestor of the Saddlestorcks. very close to the modern but in view of age given separate genus.

✓ Leptoptilus falconeri Milne-Edwards 1868
Low. Pliocene, Siwalk hills, No. India. tibia, tarsus, vert.
Like Leptotpilus argala but larger

See Lambrecht 328-330 for spread of storks. Believes their center to have been Africa.

Family Threskiornithidae EUROPE (Eo.) BOAMER (Mio). AUSTRALIA (Plio.)
✓ Ibis pagana Milne-Edwards 1868.
Up. Oligo France. Up. Mio. Steinheim. Compared with the american rosy Ibis (Eudocymus)

✓ Ibidopsis hordwelliensis Lydekker 1891
Up. Eocene, Hampshire, England. Compared with Ibis longirostris and Ibis rubra. Apparently a real ibis!

✓ Ibidopodia palustris Milne Edwards 1868 Up Olio. France
Protibis cnemialis Ameghino 1891. Miocene, Patagonia.

Ibis conditus and P. Ralphus australensis Miocene, Australia

Suborder Phoenicopteri, Family Agnopteridae
Agnopterus laurillardi Milne-Edwards 1871
Up. Eocene, Frankreich

Agnopterus?hantoniensus Lydekker 1891

Family Scaniornithidae (under suborder Phoenicopteri)
Scaniornis lundgreni Lames 1890
Up. Cretaceous, Danmark. Humerus, coracoid, scapula.
Possibly had relationship to herons as well as flamingoes.

Parascaniornis stensioi, Lambrecht 1933.
Up. Cret. Denmark. Vertebra, Ancestral family to flamingoes and herons

Family Phoenicopteridae EUROPE(EOC), AMER(MIO,)
Palaeolodus ambiguus Milne-Edwards 1871
Up. Oligg. , France; Up. Miocene Steinheim and Ries. Nearly complete skeletal material.
Scapula and sternum can hardly be distinguished from Phoenicopterus

Palaeolodus crassipes M.E. 1871
Up. Oligocene, France. Several elements.

Palaeolodus goliath M.E. 1871.
Up. Oligocene, France. Vertebra

Palaeolodus minutus M.E. 1871
Up. Oligo. France, Up. Miocene Goldberg.

Palaelodus steinheimensis O. Fraas 1870.
Up. Miocene, Steinheim

Elornis littoralis Aymard 1856
Low. Oligo. France

Elornis grandis Aymard 1856
Low. Oligo. France.

Elornis?anglicus
Up. Eocene, Hampshire, England. Humerus (maybe 2 tibiotarsi)

Megapaloelodus connectens Miller 1944
Low. Miocene. So. Dakota + Calif.

Phoenicopterus croizeti Gervais 1852.
Up. Oligocene. France. Many elements. Beak less bent downward than now
Phoenicopterus sp. appears in Italy and Mauritius

Phoenicopterus copei Shufeldt 1892.
Pleistocene Oregon and Calif.

Phoenicopterus stocki L.Miller 1944
Pliocene, Mexico.

Phoenicopterus minutus Howard
Pleisto, Calif.

ANSERIFORMES

Family Anatidae

Subfamily Romainvillinae CRET, E & EUROPE

✓ Gallornis straeleni Lambrecht 1931
Cretaceous, Auxerre, France. Femur and humerus frags.
Between the genus Anas and Cygnus.

Romainvillia stehlini Lebedinsky 1927
✓ Up. Eocene, France. Carpus, Tarsus, Coracoid. Carpus most closely appraoches Dendrocygna, but differs from it and all other Anatids.

(3) Subfamily Dendrocygninae EUROPE (Oligo); AMER (Mio)

✓ Dendrochen robusta Miller, 1944.
Lower Miocene So. Dakota. Humeru, tibia, carpus.

✓ Dendrocygna eversa Wetmore 1924
Up. Pliocene. Arizona. Humerus.

Dendrocygna validipennis DeVis 1888
Pleistocene, Queensland, ulna.

✓ Chenornis graculoidea Portis 1884
Up. Oligo, Italy. Several elements. possibly not of this subfamly

(7) Subfamily Merginae SO AMER (OLigo); AS/A (Plio) N. AMER PLEIST

✓ Eoneornis australis Ameghino 1895
Up. Miocene, Patagonia. Questionable assignment to this subfamily

✓ Eutelornis patagonica Ameghino 1895
Up. Miocene, Patagonia . Subfamily?

✓ Loxornis clivus Ameghino 1895.
Up. Oligo. Patagonia. Subfamily?

✓ Mergus sp.
Low. Pliocene India, and Polgardi and Pleistocene Oregon, Calif.?

5½ Subfamily Eonessinae
✓ Eonessa anaticula Wetmore 1938 (near Erismaturinae) articulated bones of wing
Eocene Utah. Earliest american anatid.

(6) Subfamily Erismaturinae
Biziura exhumata DeVis1889 Pleistocene Queensland
Erismatura jamaicensis, Pleistocene Calif. Oregon, etc.

5 Fuligulinae EUROPE (Oligo)

✓ Fuligula arvernensis Lydekker 1891
Up. Oligo. Puy de Dome.

✓ Fuligula aretina Portis 1889
Up. Plio. Tuscany.

✓ Fuligula sepulta Portis 1889.
Up. Pliocene Tuscany.

Nyroca robusta DeVis 1888. Pleisto Qustensland also N. reclusa, Neffodiata

Nettapus eyrensis DeVis 1906. Pleisto Eyre-See

(4) Subfamily Anatinae EUROPE(Oligo.) AMER(Mio)

Anas, represented by species from the following ages and places
Up. Oligo -- France (5); Brussels (1)
Low.Mioc. -- Framce (1)
Mid Mioc. -- Sansan, Gers (2)
Up.Mioc. -- Hahnenberg
✓ Oligocene Europe (6)
Miocene Europe (8) 16 from Europe
✓ Pliocene Europe (2)
Pleistocene Queensland (3)
✓ Anatidae indet from Up. Plio Arizona.
✓ Nettion bunkeri Wetmore, 1944
Up. Plio. Kansas

✓ Nettion carolinense Plio Texas

✓ Querquedula integra Miller, 1944
Low. Mio. So. Dakota

✓ Querquedula sp. Wetmore
Up Pliocene, Arizona

Q. floridana Shufeldt 1917. Pleistocene Fla.

Euryanas finschi (Van Neneden) 1875
New Zealand Pleistocene

(2) Subfamily Anserinae EUROPE(Oligo) AMER(Mio) ASIA(Plio)

Anser represented by species from following ages and places
✓ Oligo. Puy de Dome (1)
✓ Miocene Europe (4)
✓ Pliocene Europe (1)
✓ Pliocene Asia (1)
Pleistocene Amer.

✓ Branta represented by species from following ages and places
Pliocene America (3)
Pleistocene Amer. (3 and some recent forms)

✓ Anabernicula minuscula
Pliocene and Pleistocene America

Chendytes lawi
Pleistocene America (Calif.)

✓ Presbychen abavus Wetmore 1930
Miocene Calif. Tibia. Oldest anserine in A. Amer.

Subfamily Cereopsinae
Cnemiornis, Pleistocene N.Z. 3 sp.
Cnetrornis majori, subfossil Madagascar

Subfamily Plectropterinae
Chenalopex, 3 sp. from Pleisto So. Amer.
Sarcidiornis mauritianus Pleistocene Mauritius

① Subfamily Cygninae EUROPE (Olig.) AMER (Mio)
✓ Cygnopterus affinis (Van Bebeden) 1883
Up. Oligo Rupelmonde

✓ Cygnavus senckenbergi Lambrecht 1931
Up. Oligo. Wiesbaden

Cygnus, represented by species from the following places and ages:
✓ Up. Oligo, Preschen in Bilin Europe
✓✓ Miocene Hungary Miocene America (Arizona)
✓✓ Pliocene Europe Pliocene America
Pleistocene Malta, America, etc.

Sthenelides
~~Mute Swan~~ America Pleistocene

Cygnopsis cygnoides Pleistocene China

Archaeocycnus lacustris Pleistocene Australia
Chenopis (2) " "

✓ Paranyrocidae (Family near swans)
Paranyroca magna Low. Mioc. S.Dakota Miller 1939

Eocathartidae
Eocathartes grallator Wetmore 1944.
Up. Eocene, Wyoming

Cathartidae EUROPE (Eoc.) AMER (Oligo)
Palaeogyps prodromus Wetmore 1927
Oligocene, Colorado

Phasmagyps patritus Wetmore 1927
Oligocene Colorado

Plesiocathartes europaeus Gaillard 1908
Up. Eoc.-Low.Oligo France

Sarcorhamphus patruus Lonnberg 1902
Pliocene, Bolivia

Sarcorhamphus kernensis Miller 1921
Pliocene California

Sarcorhamphus fossilis(Moreno & Mercer) 1891
Pleistocene Argentina

Breagyps clarki(Miller)
Rancho La Brea Pleistocene

Gymnogyps amplus Miller
Pleistocene Calif.

Coragyps occidentalis Miller
Pliestocene America

Near Gyparchus, Pleistocene Brazil

Cathartes aura, Pleistocene Calif.etc.

Teratornithidae
Teratornis merriami
Cathartornis gracili
Both from Pleistocene America only

Sagittariidae
Amphiserpentarius schlosseri Gaillard 1908
Up. Eoc. Low. Oligo France

Amphiserpentarius robustus 'Milne Ed. 1870
Up. Oligo, France.

Accipitridae
Aegypiinae
Palaeoborus howardae Miocene Nebraska Wetmore 1936
Palaeoborus rosatus Low. Mio. So. Dakota Miller, 1939
Neophrontops vetustus Mid.Mio. Nebraska Wetmore, 1943.
Palaeoborus umbrosus Pliocene, New Mexico Cope 1874
Neophrontops dakotensis Plio, So. Dakota, Compton 1935
Neogyps errans Miller 1916,Pleistocene Calif.
Neophrontops americanus Miller, Pleistocene,Calif.
Gyps from Pleistocene Malta and Italy
Aegypiine, sp.? Pliocene No. China
Lithornis vulturinus Owen 1841
Low. Eoc. London, Sheppey Is. Appears to be an ancestral vulture but whether to the Aegypiines or cathartids is not known, or an extinct vulturine group .

Circinae

Palaeocircus cuvieri Milne E. 1871. Related to what?
Up. Eoc. England. Carpus, femur, phalanx

Palaeohierax gervaisi Milne E. 1871. (Subfamily?)
Up. Oligo. France and Up. Eoc. England. Refers to as having similarity to Gypohierax which is an Aegypiine.

Eagles

Haliaetus piscator M.E. 1871
Mid Mio. France

Haliaetus leucocephalus Pleistocene America

Spizaetus grinnelli and willetti, Pleisto. America and S. pliogryps

Aquilavus hypogaea M.E 1891
Up Eo. Low. Oligo France. Referred by M.E. to Aquila

Aquilavus depredator ME and A. priscus ME 1871
Up. Oligo France. Both original y referred to Aquila, Could all be 1 sp.?

Aquila edwardsi (Sharpe 1899
Mid. Mioc. France

Aquila sp. from several places
Russia, America, Eruope

Harpagornis moorei from Pleistoc N.Z.
and several secies from Pleistocne of Australia, Uroaetus, Taphaetus, Baaa, Palaeoleste, Necrastur

Palaetus rapax ME 1871
Up. Oligo, France

Morphnus woodwardi Miller, 1911, Pleistocene America

Wetmoregyps daggetti Miller, 1928 Pleisto. Amer.

Several Buteos, some large enough to be eagles, others hawks:
Buteo typhoius Wetmore, 1923, Mio. Nebraska
B. dananus Mioc. Nebraska
B. ales Wetmore Mioc. Nebraska
Bl contortus Up Mio. Nebraska
B. conterminus Low Plio. Nebraska
B. grangeri Oligo So. Dakota, Wetmore, 1934
B. antecursor, Oligo Wyoming, Wetmore 1933.

Urubitinga fragilis Pleistocene America

Urubitinga enecta Wetmore 1923. Mid. Mio. Nebraska

Palaeastur abavus Mid Mio Nebraska, Wetmore 1943.
related to Leucopternis, Spizaetus, Spizastur, oldest of these

Astur alphonsi Pleisto. Mauritius Newton and Gadow, 1893.

Astur sp. from Madagascar Pleisto.

Asturaetus furcillatus Pleisto. Australia DeVis 1906

Milvus deperditus M.E. Up. Oligo France.

Circus hamiltoni Pleisto N.Z. also Circus teauteensis

Thegornis musculosus Ameghino 1895 Mio. Patagonia (relations?)
also T. debilis same age and place

Terracus littoralis Aymard 1856. Low. Oligo France. Related?

Kites

Proictinia gilmorei Shufeldt Low. Plio Kansas. Likened to Rostrhamnus

Proictinia effera Wetmore 1923. Like Ictinia mississippiensis
Low. Mio. Nebraska

Falconidae AMER (MIO).

Falco ramenta Mio. Nebraska, Wetmore 1936

F. pisanus Portis 1887, Up. Plio. Italy

F. swarthi, Pleisto McKittrick

Badiostes patagonicus Ameghino 1895 Miocene Patagonia
Wetmore thinks related to falconids

Related to

Lagopterus minutus M and M 1891 Pleisto Argentina likened to
Buteo pterocles and Polybus tharus.

Foetopterus ambiguus M and M 1891. Up Plio and Pleisto Argentina
Characters of Buteo pterocles and Cathartes aura.

Palaeoplancinae under Accipitridae

Palaeoplancus sternbergi Oligo Wyoming, Wetmore 1933

Miohierax stocki Howard, Miocene California (related?)

Accipitridae

Hawk from Eocene of Mongolia thought to be ancestor of Accipitrids
Wetmore 1934

Ortyx (Amer.)
Colinus (Amer.)
Odontophorus "
Cyrtonyx "

GALLIFORMES

Superfamily Cracides
Family Megapodidae
Chosornis praeteritus DeVis 1889 --Pleisto. Australia

✓ Family Gallinuloididae -- a group standing between the true gallinaceous birds and the coots, rails and gallinules, according to Eastman, but Wemore believes it to be gallinaceous between the Megapodidae and the Cracidae.
Gallinuloides wyomingensis Eastman 1900 -Mid Eoc. Wyoming

Family Cracidae AMER (MIO)
✓ Ortalis pollicaris Miller, 1944, Miocene So. Dakota
✓ Ortalis? tantala Wetmore 1933, Miocene Nebraska
✓ Ortalis phengites Wetmore 1923 - Low. Plio. Nebraska

Palaeantyx (1 sp.) Eoc.-Olig. (Mio.?)

Superfamily Phasianoidea E
Family Tetraonidae ~~EUROPE (Eoc)~~ Amer Mio
✓ Tympanuchus stirtoni Miller 1944 -- Low. Mio. So. Dakota
Tympanuchus lulli Shufeldt 1915 -- Pleistocene, New Jersey
✓ Palaeoalectoris incertus Wetmore 1930 - Low. Mio. Nebraska
also P. sp. from Miocene of Maryland
Resembles Canachites canadensis but is smaller
✓ Palaeophasianus meleagroides Shufeldt 1913 -Eocene Wyoming
Placed in this family in AOU checklist, Lambrecht places it in phasianidae without saying why in either case. (Shufeldt himself called it a pheasant.
Paleotetrix gilli Shufeldt 1892 -Pleistocene Oregon
and others from Oregon also
Family Phasianidae EUROPE (~~Eoc~~) AMER (Oligo)
✓ Taoperdix pessieti (Gervais) 1862 -- Up. Oligo Armissan
Resembles Pavo. shows closer relationship to asiatic and african faunae. Also Taoperdix keltica Eastman from same place
old world quail ✓ Palaeoperdix longipes, P. prisca and P. sansaniensis M.E.1871
all from Mid. Mioc. Sansan.
✓ Palaeocryptonyx depereti Gaillard 1908 -- Low. Oligo France — old world quail
Very close to Cryptonyx. Characters of Ortyx (Amer.), Cryptonyx (Malasia) and Palaeortyx (Europe fossil). Other species from Up
✓ Miocene Sr. Alban, ✓ Up. Pliocene Roussillon
quail ✓ Cyrtonyx cookii Wetmore 1933, Miocene Nebraska
✓ Miortyx teres Miller, 1944, Low. Mio. So. Dakota
Bob white ✓ Colinus hibbardi Wet ore 1944, Low Plio. Kansas
✓ Colinus sp. Up. Plio Arizona (Wetmore 1924)
old world partridge ✓ Francolinus capeki Lambrecht 1933 -Up Plio Hungary
Archaeophasianus roberti (Shufeldt) 1915 --Up Oligo Oregon
✓ Archaeophasianus miocaenus (Shufeldt) 1915 - Miocene Nebraska
This genus very Pheasant like (compared with P. colchicus. Shufeldt remarks that true pheasants of this county became extinct but imported ones from the Orient now thrive well here.
✓ Miophasianus altus (ME) 1871 Mid Mio and Up Mio France
✓ Miophasianus medius ME also 2 others from Miocene of France
✓ Phasianus archiaci Gaudry 1862 - Low Plio Pikermi (in Athen)
Phasianus hermonis - Pleisto Palestine
✓ Phasianidae sps. Plio Nebreaska
✓ Anissolornis excavatus Amerhino 1891 Mioc. Patagonia
✓ Miogallus longaevus (v.Ammon) 1918 -Up. Mio. Regensburg. referred to Gallus
✓ Gallus bravardi Gervais 1859 Up Plio France
✓ Gallus aesculapi Gaudry 1861 - Low Plio Russia (European Rus.)

Family Meleagridaidae

Parapavo californicus Miller 1909 - Pleistocene Calif., Plio Texas

Agriocharis sp. - Up Plio Arizona Wetmore 1924

Mealagris antiqua Marsh 1871 -- Oligo, Colorado

Mealeagris richmondi - Pleistocene Calif.

Meaeagris celer Marsh 1872 - Plesito, ~~Colorado~~ New Jersey

Two other sp. of Mealeagris from Pleisto Fla. and Penn.

Family Phasianidae continued

Palaeortyx hoffmanni (Gervais) 1859 - Up Eocene Montmartre, France

Palaeortyx blanchardi ME 1871 same place and age

Palaeortyx caluxensis Lydekker 1891 -Up. Eoc. Low Oligo France.

3 other species from same place

P. gallica Up. Oligo France 3 others from same place

P. maxima, grivensis, depereti and joleaudi miocene France

Paraortyx lorteti Gaillard 1908 - Up. Eoc. Low Oligo France

also P. brancoi True quail

Suborder Opisthocomi?

Filholornis paradoxa and gravis and debilis ME 1891 - France Up.Eo.Lo.Olig

Resembles Hoatzin and Touracos and Calaos. Gaillard thinks it points to origin of Hoccos, Penelopes and Hoazin.

EOCENE GRUIFORMES

Suborder Gruae
Family Geranoididae
Geranoides jepseni - Wetmore 1933 -Low. Eoc - Wyom. Crane-like large Eo
Family Gruidae
Eogrus ardeola - Mongolia Up. Eoc. Wetmore 1934.Tibia and tarsus Running form like cranes and aariams, possibly weak flight. Show relationship with Cariamae and Otides, bringing these and Grues a step nearer to a common acnestral stem.
Eogrus sp - Oligo Mongolia
Eogrus sp. - Mio - Mongolia

Family Gruidae
Geranopsis hastingsiae Lydekker 1891 . Up. Eoc. France.Crane-like
Paleogrus, 1 from Mid Eoc - Italy; 1 Up Eoc Hampshire; 1 Up. Oligo of France. Very Grus like.
Paragrus prentici (Loomis) 1906 - Low Eoc. Wyo. True crane.
Protogrus nobilis (Marsh) 1872 Mid Eoc. Wyo. Very crane like
Protogrus marshi (Shufeldt) 1915 - Mid Eoc, Wyo.
Pliogrus germanicus Lambrecht 1933 - Low. Plio Eppelsheim -Tibia
Pliogrus pentelici (Gaudry) 1862 - Low Plio. Pikermi (Athens?)
Grus nannodes Wetmore and Martin 1930 - Plio, Kansas
Grus conferta Miller, 1942, Plio No. Calif.
Grus americana Pliocene of Idaho(Loye Miller)
Urmiornis maraghanus Mecquenam 1925, Low Plio, Persia -cranelike
Probalearica problematica (MilneOEdwards)1871 - Up. Oligo France. Ancestral to the crowned cranes (Balearica)
Grus melitensis Lydekker 1890 Pleisto. Malta
Grus proavus Marsh 1872 Pleisto. New Jersey, smaller than cana.
Grus canadensis and G. americana from Pleisto Amer.

Family Aramidae
Gnotornis aramiellus Wetmore 1942 - Oligocene So. Dakota
Badistornis aramus Wetmore 1940 - Oligo So. Dakota
Aramornis longurio Wetmore 1926 - Mid Mioc. Nebraska
Aramus pictus - Pleistocene Fla.

Laornis edwardsianus Marsh 1870 - Eoc. New Jersey - Screamer?Crane? or what other wader?

Family Orthocnemidae
Orthocnemus minor, gallicus, major - Low Oligo - France
Relationships seem foggy. Genera Chauna, Haematopus Grus mentioned also the Ciconiidae.
Elaphrocnemus phasianus, gracilis, crex - Low Oligo France
Resmebles Aphanapteryx bonasia, "Rails with long legs", courlans, jacanas

Family Rallidae
Quercyrallus dasypus ME 1891. Up Eoc.-Low.Oligo France. Not quite Rallus
Quercyrallus arenarius (ME) Up EO-Low.Oligo France
Quercyrallus intermedius (ME) 1871 Up. Eo. Montmartre. Raillike but differs from modern.
Palaeoramides christyi (ME 1871) Up Oligo France Rallus and Aramidea
Paraortygometra porzanoides (ME) 1871 -- Up Oligo - France
Likened to Porzana.
Rallicrex kolozsvarensis Lambrecht 1933 --UP. Oligo.Siebenburgen
Resembles Rallus and Crex
Eocrex primus Wetmore 1931 -- Eocene, Colo. Between subfamilies of rallinae and gallinulinae but nearer the latter Prob'ly swam
Telecrex grangeri Wetmore 1934 - Up Eco. Mongolia ancestor of Rallinae

Palaeocrex fax Wetmore 1927 -- Oligocene, Colo.
Related to gallinules rather than coots
Palaeorallus troxelli Wetmore 1931 Eoc. Wyo. Rallinae, walking rathr than swimming in deep water.
Pa rarallus dispar (ME) 1871 -- Mid Mioc. Sansan.
Seems to have characters of both rails and gallinules
Miorallus major ME 1871 - Mid Mioc Sansan
Rallus dubius -Portis 1887 -- Low Plio. Sinigaglia(Italy ?)
Rallus prenticei Wetmore 1944, Up Plio Kansas
Aphanapteryx bonasia Pleisto. Mauritius
A. leguata Pleisto? Rodriguez
Diaphorapteryx hawkinsi Quat. N.Z.
Gallirallus minor Pleist. NZ
Crecoides osborni Shufeldt 1892 Plioc. Texas. Related to genus Crex of the Rallidae.
Microtribonyx effluxus De Vis 1892. Pleisto NZ Australia
Tribonyx [illegible] robe ti Nadrews 1897. Pleisto Madagascar
Gallinula stremuipes De Vis 1888. Pleisto Australia
and anothr G from asame place and age
Gallinula chloropus Plio IdahoWetmore 1933 and Pleisto Fla.
Gallinula sp. Up Plio Arizona (Wetmore 1924
Thiornis sociata Navas 1922. Plioc. Spain. Skeletal impression. Related to the Gallinules.
Porphyrio reperta De Vis 1888 Pleisto Australia
Porphyrio mackintoshi De Vis 1892. Pleisto Australia
Notornis mantelli Owen 1848 - this and anoth N. Pleisto NZ
Fulicaletornis venustus (Marsh) 1872. Close to Fulica UPEOC.Wyom.
Miofulica dejardini (Van Babeden)1872. Up Mio. Antwerp
Fulica [illegible] americana Pleisto N.AMer.
F. newtoni Pleisto Mauritius
F. prior Pleisto Australia
Palaeolimnas chathamensis Pleistocene Chatham Islands
Palaeolimnas prisca Pleisto NZ, Nesloimnas dieffenbachi ChathamIs.
Aptornis, 2 sps. N.Z. Pleisto
Telmatornis [illegible] priscus Marsh 1870 Eocene New Jersey. Relationship to rails questionable
Telmatornis [illegible] affinis and rex Eoc N.J.
Gypsornis cuvieri ME 1871 UP Eoc. Montmartre --Rallidae

Family Bathornithidae
Bathornis (4 species), Color. Nebraska, So.Dakota, Wyom.
Family belongs with the Suborder Cariamae
Family Phororhacidae
9 or more gnera from [illegible] Oligo and Mio S. Amer.

ORDER DIATRYMIFORMES

4 or 5 species from Eocene Wyom., N. Mex., N.Jersey and 2 from Europe?

Family Otididae
Palaeotis weigelti Lambrecht 1928 -Mid. Eoc. Merseburg
Otis agilis ME Up Oligo France
Otis affinis Lydekker 1891, Up Mio Bavaria
Also anne Otid from Queensland Pelsito

CHARADRIIFORMES

Superfamily Charadrioidea

Family Rostratulidae (Painted Snipe)

Rhynchaeites messelensis Wittich 1899 - Eocene(Mid), Darmstadt
Skeletal impression
Belongs between the rails and Limicolae

Family Haematopodidae

Paractiornis perpusillus Wetmore 1930, Low Mioc. Neb.
Resembles Haematopus palliatus

Family Rhegminornithidae

Family in the superfamily Charadroidea near the Jacanas
Rhegminornis calobates Wetmore 1943 -- Low. Mio Fla.

Family Charadriidae

Subfamily Vanellinae

Vanellus selysi Van Beneden 1872 -- Up Oligo, Belgium -Humerus
Lobivanellus sp. DeVis 1892, Pleisto Australia -Tarsus

Subfamily Charadriinae

Charadrius sheppardianus Cope 1881 - Up Miocene, Colo. leg andpelvis parts and modern Eupoda, Oxyechus and Squatarola from Pleisto Amer.
Dolichopterus viator Aymard 1856 - Low Oligo France (Larid?)
Limicolavis pluvianella Shufeldt - Olig? Oregon. (Family questioned)

Family Scolopacidae

Subfamily Tringinae

Palaeotringa littoralis Marsh Eocene, N.Jersey (Gull?)
(and 2 others)
Tringa gracilis ME 1868 -Up Oligo. France -- many elements and 2 others at Tringa sp. from same area and age
Tringa sp. - Low Plio, Italy (Portis 1887)
Tringa? bellus(Marsh) 1872 - Mid Eoc. Wyom. frg. tarsus which Marsh assigned to the Gruiforms and Shufeldt thought a shorebird. Should not base conclusions on this minute fragments.

Subfamily Numeniinae (of AOU checklist) not recognized by Peters

Totanus edwardsi Gaillard 1908 Up Eoc. Low. Oligo - France - Humerus
Totanus sp. Up Eoc Montmartre - probably a near relative of Totanus
Totanus sp. Up Mio. Oeningen - Tibia and tarsus
Totanus lartetianus ME 1868 - Up Oligo France - several elements
Totanus majori Lydekker 1893, Up Mio. St. Alban (France)
Totanus grivensis Ennouchi 1930. Up Mio. France
Totanus minor Ennouchi 1930 - Up Mio France - Humerus
Totanus praecursor Laube 1901 - Low Miocene - Bohmen.
Totanus scarabellii Portis 1887 - Low Plio Senigallia
and 3 recnt forms (Totanus mel., Numenius and Phaeopus) from Pleis.Amer.

Subfamily Scolopacinae

Coenocorypha chathamica (Forbes) 1893 - Pleisto Chatham Is.
Capella anthonyi (Wetmore) 1920 - Quat. Porto Rico.
Capella delicata - Pleisto Amer.
Philohela gracilis (Marsh)1872.- Up Eoc. Wyom (originally with Gruids.
Graculavus pumilus Marsh 1872 - Eocene NLJersey (not a cormorant!)
Limnodrom modern from Pleisto Amer.

Subfamily Eroliinae

Pelida alpina Pleisto Amer.
Micropalama hesternus Wetmore 1924, Up Plio Ariz.
Eloriau paludicola ME 1868 Up Oligo France

Family Recurvirostridae

R. americana - Pleisto Amer.

Family Presbyornithidae
Presbyornis pervetus Wetmore 1926 - Eocene Utah.
Ancestral stock of avocets and Himantopodae.

Family Phalaropodidae
Bobipes lobatus - Amer. Pleisto.

Suborder Lari
Family Stercorariidae
Stercorarius shufeldti Howard - Pleisto. Oreg. and Calif.
Family Laridae
Subfamily Larinae
Gaviota niobrara Miller 1941 - Mio. Neb.
Suggests link of Laridae and Scolopacidae from which true larids emerged after the Miocene. Oligo Larids from Europe resamble Scolopacids.
6 sp. Larus - Pleisto Amer.
The following species of Larus from Europe may therefore be Scolopacids
Larus desnoyersi ME 1868 - Up Oligo France many bones
Larus elegans ME 1868 - Up Oligo France many bones
Larus totanoides ME 1868 - Up. Oliog France many bones
Larus raemdoncki Van Beneden 1871 Up Oligo Belgium Humerus
Larus pristinus Shufeldt 1915 - Oligo? Oregon (frag. tibia)
Larus sp. Up Miocene of Lierheim in Hahnenberg
Subfamily Sterninae
Sterna Milne-Edwardsi Riabinin 1931 - Up Tertiary Transcaucasus
Pseudosterna degener Mercerat 1897 - Miocene - Argentina
Pseudosterna pampeana Mercerat 1897 - Miocene a. Amer.

Family Alcidae
Subfamily Nautilornithinae
Nautilornis avus Wetmore 1926 - Eocene Utah
Nautilornis proavitus Wetmore 1926 - Eocene Utah.
Auk with wings specialized for under water flight to a lesser extent than in modern forms. Both wing and leg relatively longer than in modern species. Less distinctly aquatic -- wader.
Hydrotherikornis Oregonus - Miller 1931 Eoc.(U) Oregon. As well developed for swimming and diving as modern auks.
Subfamily Alcinae
Mancalla californiensis (now separate family
Uria antiqua (Marsh) 1870 - Miocene No. Carolina Humerus
Hardly distinguishable from Uria lomvia
Uria ausonia Portis 1887 - Plio Italy Humerus
Uria sp. Up Plio, Pisa (Regalia 1902) -Coracoid
Miocepphus Mcclungi Maryland Wetmore 1943. - Mio
Uria affinis Marsh 1872 - Pleisto No. Carolina
Uria aalge -- Pleisto Calif.
Plautus impennis - Quat. N.AMer.
Brachyramphus pliocenus - Plio Calif.
And modern Brach. from Pliesto Amer.
Cerorhinca dubia Miller, Mio Calif.

Grebes

Loons

EOCENE

Colymboides anglicus

Characters similar to both grebes and loons.

Europe

OLIGOCENE

Colymboides minutus
(Between grebes and loons)

Colymbus oligocaenus
A true grebe

U.S. (Oregon)

MIOCENE

No Miocene records of either grebes or loons

PLIOCENE

3 species of Colymbus (extinct)
(one
Odessa + Arizona, Calif.

PLIOCENE

3 species of Colymbus
(2 extinct, the other
C. nigricollis)

U.S. (Kansas, and Calif.)
Europe

PLEISTOCENE ← grebes

5 modern species, 1 extinct

All genera modern

U.S.

OLIGOCENE

Colymboides minutus
(Between grebes and loons)

Gavia pusilla (a true loon)

Gaviella

U.S. (Wyoming) Age, probable

~~Colymboides minutus Hunt. Obs.~~

MIOCENE

~~No Miocene records of loons or of grebes~~

Gavia palaeodytes (very small)
Pla. Up Mio.

PLIOCENE

2 extinct species of Gavia

One from Europe
One from U.S. (Calif.)

PLEISTOCENE

Large Gavia (probably immer)

U.S. (Calif.)

Procellariiformes

EOCENE

Gigantornis eaglesomei

Between Tubinares and Steganopodes.

Africa

OLIGOCENE

Hydrornis natator

Possibly between the Tubinares and Anseriforms.

Also a true Puffinus (of extinct species)

Europe

MIOCENE

3 extinct sps. Puffinus America

1 " " Fulmarus America

2 " " Procellaria Europe

1 " gen. and sp. (Plotornis delfortrii) Europe
(Similar to Diomedea) but in Procellaridae
2 Diomedeas (extinct) America
Europe and U.S.

PLIOCENE

Extinct species of Diomedea
(occurs in Mio of America)
England
2 Puffinus - America

PLEISTOCENE

Modern Albatross, Fulmar, Shearwater

2 extinct petrels (Bermuda & S.A.)

Passeriformes

EOCENE

3 extinct species of family Laniidæ (extinct genus Laurillardia)

1 extinct species, family Paridae ("head of Sylvia, feet of Parus") (Palaegithalus cuvieri) (between a titmouse and an old world warbler)
Europe

OLIGOCENE

1 extinct species, genus Lanius

2 extinct species of wagtail (modern genus Motacilla)

Europe

MIOCENE

2 extinct genera (1 of extinct fam. Palaeospizidae near Laniidae, the other a fringillid)
America

2 other fringillids -- Europe

1 extinct crow or raven -- Europe

PLIOCENE

2 extinct larks -- Europe

4 extinct corvids (raven-like)
1 extinct nuthatch
1 extinct pipit

Europe (all the above)

1 junco -- U.S.(Arizona)

PLEISTOCENE

Many modern species; but also

1 extinct swallow (may be modern)
1 " corvus
2 " Palaeocorax -- New Zealand
1 Pyrrhocorax primigenius --France
1 thrush, 1 blackbird, 1 cowbird?

Pelecaniformes

EOCENE

Family Phaetontidae (Low.)
Prophaeton shrubsolei -England
near common stem with Sula and
cormorants -- good swimmer

Family Pelecanidae
Protopelecanus -- Europe (UP.)

Family Sulidae (Low.)
Possibly Argillornis longipennis
belongs here. Teeth -- England

Family Elopterygidae Europe
(Show close relationship between
cormorants and sulids)
CRETACEOUS Elopteryx nopscai
EOCENE Eostega lebedinskyi (Mid.)
Actiornis anglicus (Up.)
(England)

Family Phalacrocoracidae
None in Eocene (Probably Elopteryg-
idae were ancestral)

Family Anhingidae
Protoplotus beauforti -Sumatra
(Better flyer than today)

Family Odontopterygidae
(Relations to modern?)
Odontopteryx toliapica (Low.
(England)
Pseudodontornis longirostris (Age?)
Brazil

OLIGOCENE

Family Pelecanidae
1 extinct sp. - France
(Pelecanus UP.)

2 ext. sp. Sula -France
(up. and Low.)

Family Phalacrocoracidae
2 Oligocorax - France
2 Oligocorax -Amer.
Oregon, Colo.

Family Anhingidae
NONE

MIOCENE

Family Pelecanidae
3 Pelecanus Up. Europe

Family Cyphornithidae --Amer.
pelican-like but show distant
relationship with cormorants,
sulids and anhingas. Distant
reltionships of pelicans to gannets
and more remotely to cormorant-
anhinga branch.
Cyphornis magnus -- Canada
Palaeochenoides miocaenus -So.Carolina

Family Sulidae
Possibly Liptornis hesternus -S.Amer.
(Pelican and sulid chars.)

1 lsp. Sula - France (Mid.)
3 sp. Sula - Amer. (Calif.)
1 sp. Miosula - Amer.(Calif.)
2 sp. Morus - Amer.(Maryland,Calif.)

Family Phalacrocoracidae
1 Miocorax - Calif.
2 Miocorax - Europe
1 Phalacrocorax auritus Fla. (Mid.)
Famly Anhingidae NONE

PLIOCENE

Family Pelecanidae
2 Pelecanus -- Amer. (1 mod.sp.?)
3 Pelecanus -- Asia (Low.)
(1 is from Odessa)

Family Sulidae
1 Miosula - Calif.
(small wings large legs between
sulids and cormor in habit)

Family Phalacrocoracidae
2 ext. sp. Phalacrocorax -Amer.
(Calif.
1 Paracorax - Europe (Italy) (up.
1 Paracorax India (Low.)
1 P. auritus - Amer.

Family Anhingidae
1 extinct Plotus - Hungary (Low.)

FIRST APPEARANCES

Family Phaetontidae -L.EOC. Europe (near stem with sulids
Pelecanidae - EOCENE EUROPE;PLIO AMER. (replaced by Cyphornithidsin MIO)
Sulidae -L. EOC.? EUROPE, or in OLIGO; MIOCENE N. and S. AMER.
Phalacrocoracidae - CRET. and EOC. Elopterygids link with sulids -Europe
OLIGO - Amer.
Anhingidae - EOCENE, Sumatra; PLIO, Europe.

ANSERIFORMES

EOCENE

Family Anatidae
*Subfamily Romainvillinae
Gallornis CRETACEOUS -Europe
Romainvillia EOCENE (U.)*Europe
(between ducks and swans)
*Subfamily Eonessinae/ Eonessa -Utah

OLIGOCENE

Family Anatidae
(3) Subfamily Dendrocygninae
Chenornis graculoides -Italy (U.)
(possibly not this sub fam.)
(6) Subfamily Merginae
Loxornis clivus -Patagonia (U.)
(5) Subfamily Fuligulinae
Fuligula arvernensis - Europe (U.)
(4) Subfamily Anatinae
6 Anas - Europe
(2) Subfamily Anserinae
Anser - Europe
(1) Subfamily Cygninae
Cygnopterus affinis -Europe (U.)
Cygnavus senckenbergi -Europe (U.)
Cygnus - Europe (U.)

MIOCENE

Family Paranyrocidae
(extinct family near the swans)
Paranyroca magna -Amer.(L)

Family Anatidae
Subfamily Cygninae
Cygnus - Eruope and Amer.
Subfamily Anserinae
Anser (4) - Europe
*Presbychen abavus -Amer.
Subfamily Dendrocygninae
Dendrochen robusta - So.Dak.(L.)
Subfamily Anatinae
8 Anas - Europe
Querquedula intégra -S.Dak.(L)
Subfamily Fuligulinae NONE
Subfamily Merginae
Eoneornis australis - Patagonia (U)
Eutelornis patagonica " "

PLIOCENE

Family Anatidae
Subfamily Cygninae
Cygnus - Europe and Amer.
Subfamily Anserinae
Anser Europe and Asia
Branta, America(3)
Anabernicula Amer.
Subfamily Dendrocygninae
Dendrocygna eversa -Ariz.(U)
Subfamily Merginae
Mergus sp. - India (L)
Subfamily Anatinae
Anas - Europe - Amer.
Subfamily Fuligulinae
Fuligula - Europe

FIRST APPEARANCES

CRETACEOUS - subfamily between ducks and swans-EUROPE
EOCENE - same subfam persisted in Europe. Another in Amer. related to Ruddies.
MIOCENE -Amer. extinct family near swans.

SWANS
America - MIOCENE, Europe OLIGO
GEESE
Europe OLIGO; Amer. MIOC
Asia (PLIO)
DUCKS
N.America EOCENE (Extinct subfam)
So. Amer. OLIGO (Fulig.)Merg.)
N.AMEr. Anat and Merg. MIOC
N america Mergines PLEIST.
Europe -EOCENE (extinct subfam)
Europe -OLIGO all others except Mergines

ANSERIFORMES

Family Paranyrocidae
Paranyroca magna

Ciconiiformes

EOCENE

Family Ardeidae
Proherodius oweni - England (Low.
Eoceornis ardetta - Wyo.
Relations of these not clear
Botauroides parvus - Wyo.
bittern-heron (small)
Family Threskiornithidae
Ibidopsis hordwelliensis
England -true Ibis

Suborder Phoenicopteri
Family Agnopteridae
Agnopterus laurillardi -France (Up.)

Family Scaniornithidae (CRETCAEOUS)
2 genera from Denmark
* relate the herons and flamingoes

Family Phoenicopteridae
Elornis anglicus - Eng. (Up.)

OLIGOCENE

Family Ardeidae
Goliathia andrewsi -Egypt (Low.)
(giant heron)
Proardea amissa -France (Low.)
resembles egrets
Ardea formosa - France (Up.)

Family Ciconiidae (FIRST)
Propelargus cayluxensis Europe (Low)
clearly storklike
also another sp.
3 Pelargodes - France (Up.)
(close to Ciconia alba)
Palaeoephippiorhynchus dietrichi
Africa (Low.) EARLIEST STORK
Ancestro of saddlestorks.
similar to modern.

Family Threskiornithidae
Ibis pagana - France (UP.)
(cf.Amer.Rosy Ibis)
Ibidopodia palustria -France (U.)
Family Phoenicopteridae
4 Palaeolodus - France (Up.)
(Close to Phoenicopterus)
2 Elornis - France (Low.)
Phoenicopterus -France, Italy (Up.)
beak less bentin P. croizeti
than in modern

MIOCENE

Family Ardeidae
Ardeacites mollassicus -Europe (L.)
cf.Botaurus stellaris
2 Botaurites - Europe (U.)
2 Ardea - Europe (U.)
1 Ardea - Europe (Mid.)

Family Ciconiidae
Psudotantalus MilneEdwardsi
Europe - (UP.)

Family Phoenicopteridae
Palaelodus steinheimensis
Europe (U.) (Oligo genus)
Megapaloelodus connectens
Low. So. Dakota

PLIOCENE

Family Ardeidae NONE

Family Ciconiidae
Amphipelargus majori - Samoa (L)
Ciconia gaudryi - Pikermi (L) Greece
Ciconia maltha - Idaho (L)
Leptoptilus falconeri -India (L)

Family Phoenicopteridae
Phoenicopterus stocki - Mexico

FIRST APPEARANCES

Ardeidae - EOCENE, Amer., Europe
Ciconiidae -OLIGO, Europe, Africa
PLIO, Amer.

Threskiornithidae - EOCENE, Europe
MIO., So. Amer.
Phoenicopteridae, EOCENE, Europe
MIOCENE, America

ANCESTRAL TYPES

EUROPE CRETACEOUS & EOCENE
Heron-Flamingo link
AMER. EOCENE Bittern-heron
AFRICA -OLIGO, anc. saddle stork
Africe the center of dispersal
of storks

FALCONIFORMES

EOCENE

Family Eocathartidae
Eocathartes grallator - Wyo. (U)

Family Cathartidae
Plesiocathartes europaeus - France (U)

Family Sagittariidae
Amphiserpentarius schlosseri -France(U)

Family Accipitridae
Subfamily Milvinae NONE
Subfamily Accipitrinae NONE
Subfamily Buteoninae
Aquilavus hypogaea -France (U)
Subfamily Aegypiinae
Lithornis vulturinus -Eng(L)
ances. vulture here or
Cathartes?
Palaeochiras lewisi - Mongol (U) like Gypohierax?
Accipitridae, Hawk sp.
Mongolia Wetmore says ances.
of Accipitrids
Subfamily Circinae
Palaeocircus cuvieri -Eng (U)
Relationship here questioned?

OLIGOCENE

Cathartidae
Palaeogyps prodormus, Colo.
Phasmagyps patritus , Colo.

Sagittariidae
Amphiserpentarius robustus -France(U)
Amphiserpentarius schlosseri Frnc (L)

Family Accipitridae
Subfamily Milvinae
Milvus deperditus -France (U)
Subfamily Palaeoplancinae
Palaeoplancus sternbergi -Wyo.
Subfamily Buteoninae
Buteo from Wyo and So.Dakota
Aquilavus depredator and A. priscus
France (U) (like Aquila)
Aquilavus hypogaea -France (L)
Palaetus rapax - France (U)
Subfamily Aegypiinae?
Palaeohierax gervaisi -France
said to be like Gypohierax

MIOCENE

Family Cathartidae NONE

Family Accipitridae
Subfamily Buteoninae
4 Buteo - Nebraska
Urubitinga enecta -Nebrasks
Palaeastur abavus -Neb.(Mid)
rel'd Spizaetus, Spizastur
Aquila edwardsi -France (Mid)
Haliaetus piscator -Fr.(Mid)
Miohierax stocki -Calif
Subfamily Milvinae
Proictinia effera -Neb (L)
Subfamily Aegypiinae
Palaeoborus howardae -Neb.
Palaeoborus rosatus -S.D.(L)
Neophrontops vetustus -Neb.(Mid)

Family Falconidae
Falco ramenta - Neb.
Badiostes patagonicus -S.Amer.

PLIOCENE

Cathartidae
Sarcoramphus patruus -Bolivia
Sarcoramphus kernensis -Calf.

Accipitridae
Subfamily Milvinae
Proictinia gilmorei -Kansas L)
Subfamily Accipitrinae NONE
Subfamily Buteoninae
Buteo conterminus -Neb(L)
Subfamily Aegypiinae
Paleoborus umbrosus ONewMex
Neophrontops dakotensis -SoDak.
Aegypiina, sp. No. China

Falconidae
Foetopterus ambiguus -Argentina(U
Questionably placed here
chars of Buteo pterocles
and Cathartes aura!
Falco pisanus -Italy (U)

FIRST APPEARANCES

Vultures
Cathartine EOCENE, Amer.Europe
Aegypiinae EOCENE, Europe?
Kites MIOCENE, AMer.
IMilvinae, OLIGO -Europe
MIO - Neb.
Buteoninae EOCENE -France, China
OLIGO -So.Dak
Falconidae MIOCENE, America

GALLIFORMES

EOCENE

Family Gallinuloididae
Gallinuloides wyomingensis -Wyo (Mid)
between megapodes and cracids

Family Tatraonidae
Palaeophasianus meleagroides
(probably belongs with phasianidae)
Wyo.

Family Phasianidae
Palaeortyx (3) -France (U
Parortyx lorteti -France
quail

Suborder Opisthocomi?
Filholornis paradoxa and 2 others -France(U)

OLIGOCENE

Tetraonidae
Family ~~Phasianidae~~ NONE
Family Phasianidae
Taoperdix pessieti -France(U)
Taoperdix keltica - " "
Palaecryptonyx depereti -France (L)
chars of Amer Malayasian and
European forms (quails?)
Archaeophasianus roberti -Oregon(U)
true pheasant
Family Meleagrididae
Mealeagris antiqua - Colo.

Suborder Opisthocomi?
Filholornis paradoxa and 2 others
France - U)

MIOCENE

Family Cracidae
Ortalis (2) - S.D. and Neb.
Family ~~Phasianidae~~ Tetraonidae
Tympanuchus stirtoni -S.Dak (L)
Palaeoalectoris incertus -Neb (L)
Palaeoalectoris sp. -Maryland
Grouse
Family Phasianidae
Palaeoperdix (3) -Sansan(M)
Palaeocryptonyx -St.Alban
Cyrtonyx cookii -Neb.
Miortyx teres - S.K (L)
Archaeophasianus miocaenus - Neb.
Miophasianus - France (M and U)
Miophasianus (3) -France
Anissolornis excavatus -Patagonia
Miogallus longaevus -Regensburg (U)
Palaeortyx (4) - France(quail)

Turkeys
OLIGO N. Amer. None in S.Am. or
Europe
Hoatzin? EOCENE Europe

PLIOCENE

Cracidae
Ortalis phengites -Neb (L)
Tetraonidae -NONE
Phasianidae
Palaeocryptonys -France (U)
Colinus hibbardi -Kansas(L)
Colinus sp.- Ariz. (U)
Phasianus archiaci - Pikermi(L
Phasianidae sps -Neb.
Gallus bravardi - France (U)
Gallus aesculapi -Russia (L)
Meleagridae
Agriocharis sp - Ariz (U)
Parapavo calif. -Texas

FIRST APPEARANCES

Cracidae MIOCENE (N.AMER)
not known from Europe
EOCENE another family
between Cracids and Megapods

Tetraonidae ?
EOCENE N.AMER.?(probably a
pheasant)
MIOCENE N. Amer.
None from Europe

Phasianidae
Odontophorinae
~~Palaeortyx~~? EOCENE Europe
chars link quails of old
and new worlds.
True odontophorines MIOC
N. Amer.
Old world quail
EOCENE Europe (link)
OLIGO Europe (none in Amer.
Pheasants
EOCENE N. Amer? (or grouse)
OLIGO N. Amer.
MIOCENE -Europe
PLIOCENE *Pikermi

GRUIFORMES

EOCENE

Family Geranoididae
Geranoides jepseni Wyom. (L)
Family ~~Gruidae~~ Eogruidae
Eogrus ardeola -Mongolia(U)
indicate ancestral stem of cranes carimas and otids
Family Gruidae
Geranopsis hastingsiae -France (U)
Paleogrus -France and England
Paragrus prentici Wyom. (L)
Aletornis nobilis Wyo (Mid)
Protocrus marshi Wyo. (Mid)

Family Aramidae NONE unless
Laornis edwardsianus from N.Jersey belongs here

Family Rallidae
Rails
Quercyrallus dasypus -France (U)
and 2 others
Telecrex grangeri - Mongolia (U)
ancestor of Rallinae
Palaeorallus troxelli - Wyo.
more walkign than deep water swimmer
Gallinules
Eocrex primus - Colo. between Rallinae and gallinulinae but nearer the latter
Fulicaletornis venustus Wyo.(U)

Rallidae? Related how?
Telmatornis 4 sp. N.Jersey
Gypsornis cuvieri -Montmartre
Some sort of rallid.

Fmily Otididae
Palaeotis weigelti - Merseburg

OLIGOCENE

Family Eogruidae
Eogrus - Mongolia
Family Gruidae ~~NONE~~
Family Aramidae ~~NONE~~ SO. Dakota
Badistornis aramus - SO. DAKOTA
Gnotornis aramiellus - SO. Dakota
Family Orthocnemidae
Orthocnemus minor and 2 - France L
Elaphrocnemus (3) France
Rail with long legs
Family Rallidae
Palaeoramidas christyi -France
Rallus and Aramides
Paraortygometra porzanoides - France
Like Porzana
Rallicrex kolozsvarensis - Siebengurgen
Rallus and Crex
Paleocrex fax - Colo. (Gallinule)

OLIGOCENE cont'd

Suborder Cariamae
Family Bathornithidae
4 species from Colo. Neb. So. Dakota, Wyom.
Family Phororhacidae
9 genera So. Amer.
Family Otididae - Otis -France

MIOCENE

Eogruidae -Eogrus-Mongolia
Gruidae NONE
Aramidae - Aramornis -Neb.(M)
Rallidae
Pararallus dispar -Sansan (M)
rails and gallinules
Miorallus major -Sansan O(M)
Miofulica dejardini -Antwerp(U)
Phororhacidae - So. Amer.
Otididae -Otis-Bavaria(U)

PLIOCENE

Gruidae
Pliogrus, Eppelsheim and Pikermi
Grus nannodes -Kansas
Grus conferta - Calif.
Grus americana -Idaho
Urmiornis maraghanus -Persia
cranelike
Rallidae
Rallus dubius - Italy (L)
Rallus prenticei -Kansas(U)
Crecoides osborni -Texas
Related to Crex
Gallinula chloropus -Idaho
Galinula sp. -Ariz (U)
Thiornis sociata -Spain
gallinule

FIRST APPEARANCES

Gruidae EOCENE Europe
PLIOCENE America
(Eogruids of Mongolia may be remains of stock of cranes, cariams and otids)
Rails EOCENE -Europe, Asia, Amer.
Gallinules EOCENE Amer
Coots EOCENE Amer.
MIOCENE Europe
Aramidae EO or OLIGO Amer.
Cariamas OLIGO N. Amer. S. Amer.
Otidadae -EOCENE Europe

Charadriiformes

EOCENE

Rostratulidae
Rhynchaeites messelensis Darmstadt (M)
rails and Limicolae relationship

Scolopacidae
Palaeotringa littoralis (gull) -Amer.
(There is a close relationship between the scolopacids and the gulls)
Tringa? bellus (relationship ? -Wyom. (M)
Totanus (2 sp. France (U)
Philohela gracilis -Wyom. (U) rel?
Graculavus pumilus N.Jersey rel?

Presbyornithidae
Presbyornis pervetus -Utah
anc. to avocets and himantopus

Alcidae
Nautilornis (2) - Utah
Hydrotherikornis oregonus - Oreg(U)
early auklike forms

OLIGOCENE

Charadriidae
Vanellus selysi - Belgium (U)
Limicolavis pluvianella - Oreg.
age and relationship questioned
~~Limosavis velox - New Jersey~~

Scolopacidae
Tringa gracilis - France (2 others)
Totanus lartetianus - France (U)
Elorius paludicola - France (U)
4 sp. assigned to Larus - Europe

MIOCENE

Haematopodidae
Paractiornis perpusillus -Neb.
resembles Haematopus

Rhegminornithidae
Rhegminornis calobatus -Fla(L)
near Jacanas but in Charadroidea

Charadriidae
Charadrius sheppardianus - Colo. (U)

Scolopacidae
Totanus sp. -Europe (U)
3 other Totanus -Europe (U)
1 Totanus -Europe (L)

Laridae
Larus Sp. Europe (U)
Psuedosterna (2) So. Amer.

Alcidae
Cerorhinca dubia - Calif.
Uria antiqua - No. Carolina

PLIOCENE

Scolopacidae
Tringa sp -Italy (L)
Totanus scarabellii -Europe (L)
Micropalama hesternus -Ariz(L)

Laridae
Sterna Europe -Tertiary (U)

Alcidae
Uria ausonia -Italy
Brachyramphus pliocenas Amer.
Mancalla calif. OAmer.

FIRST APPEARANCES

Rail-shorebird relationship shown in EOCENE -Europe

Scolopacid-Larid relationship shown in Eocene and Mioc Amer.

Auklike forms of extinct family -EOCENE amer.

First scolopacids EOCENE Amer. and Europe

Charadriidae
OLIGO Amer? and Europe

Haematopodidae
MIOCENE Amer.

Link between Jacanas and Charadrioids in MIOCENE Amer.

Alcidae - ~~MIOCENE~~ Eocene Amer.
PLIOCENE Europe

Laridae
MIOCENE? Europe and Amer.
or OLIGOCENE (if they are not Scolopacids)
Oligo Europe

Ciconiiformes — Anseriformes

Pleistocene		
Pliocene	(Ciconiidae) *Amphipelargus/- Samoa Extinct species, modern genera: Phoenicopteridae - Mex. Ciconiidae - Amer., Asia	(Anserinae) *Anabernicula/- Amer. Modern genera, ext.sps.: Cygninae -Eur., Amer. Anserinae- Eur.Am., Asia Dendrocygninae - Amer. Anatinae - Eur., Amer. Fuligulinae - Europe Merginae - India
Miocene	Extinct genera and species (a few modern genera): Ciconiidae - Europe Ardeidae - Europe Phoenicopteridae - Eu.Am. Threskiornithidae - S. Am. Eur. (like Guara)	Modern and extinct gen., extinct species: Cygninae - Eu., Am. Anserinae - Eur Dendrocygninae -Am. Anatinae - Eur., Am. Merginae - So.Am. Extinct family near swans - Amer.
Oligocene	Extinct genera, and sps. (occasional mod. gen.): Phoenicopteridae - Eur. Ardeidae - Eur., Af. Ciconiidae - Euro., Af. Threskiornithidae - Eur. (like Guara)	Extinct and mod. gen., extinct sps.: Cygninae - Eur. Anserinae - Eur. Anatinae - Eur. Dendrocygninae?- Eur Merginae - So.Am. Fuliginae - Eur.
Eocene	Extinct genera and species: Phoenicopteridae - Eng. Ardeidae - Eng., Am. Threskiornithidae - Eng. (Guara-like) Extinct family related to flamingoes {Agnopteridae} - Eur.	Extinct subfamilies of the Anatidae Romainvillinae - Eur. (bet. ducks and swans Tonessinae - Amer. (near ruddies)
Cretaceous	Extinct family Scaniornithidae - Denmark (related to herons and flamingoes)	Extinct subfamily of Anatidae Romainvillinae - Eur. (bet. ducks and swans)

Ciconiiformes

Anseriformes

Pleistocene

Pliocene

Modern and extinct genera
Extinct species
Representing
Phoenicopteridae -Mexico
Ciconiidae - Samoa, Amer.
and Asia

Life forms at various geologic ages

ARCHEOZOIC -- graphite deposits indicating organic matter (carbon)
no types designated

PROTEROZOIC -- sponge spicules, worm burrows, calcareous algae

PALEOZOIC

Cambrian -- Calcareous algae . ALL MARINE
Trilobites most abundant (35%?) also a few other Crustacea, and toward end of period a few marine arachnids (all together 37%)
Brachiopods (20%))
Sponges (18%?)
Jellyfish (no other coelenterates)
Primitive echinoderms Cystoidea } 2%
gastropods (no other molluscs) 10%
Worms (tubes, trail, burrows found)(4%)
Protozoa — Foram? Radiolaria?

Ordovician -- development of armored forms (ALL MARINE)
Graptolites and corals abundant in colonies
Greater variety of echinoderms (first starfish, sea urchins, crinoids blastoids
Bryazoa in profusion
More gastropods, also pelecypods and cephalopods added
Protozoa and sponges present but unimportant in numbers
Trilobites reach climax of evolution. Other arthropods added: water fleas, ostracods, barnacles, eruypterids
First chordates -- Ostracoderms, bony and fish-like

Silurian -- prominent Ordovic. groups begin to decline, lesser ones rise
Graptolites declining, corals expanding in number and distribution
Bryazoa common and found in reefs
Brachiopods expanding
Cystoid echinoderms common, crinoids in profusion
Gastropods, nautiloids, clams
Trilobites present but past their prime
Eurypterids most distinctive of Silurian, but not widely distributed
Octracods maintain abundance
X First indication of land animals (millipeds) and scorpions may have been of the land
X First indication of land plants (fragments of club mosses)
Ostracoderms well defined, primitive elasmobranchs possibly present

Devonian --
Brachiopods at their best.
Coral reefs in which lived Bryozoa and crinoids
Pelecypods more diversified
Beginning of ammonites
trilobites on the wane
starfish, echinoids and blastoids ascending. Crinoids still abundant
Siliceous sponges
Fishes abundant, but no true bony fish (teleosts). Large sharks
Ganoids and lungfish abundant
First indication of amphibia (footprints and bones of Stegocephs)
Land plants include primitive rootless forms, also primitive ferns, and horsetails. Club mosses get large. Seed ferns known.
Sowbugs appear. Spiders and mites present

Rootless = Psilophytales
Spiders

PALEOZOIC continued

Mississippian -- marine life better known due to avail. deposits
Decline of trilobites and corals
Expansion of echinoderms, lacy Bryozoa and spiny Brachiopods
Crinoids at heighth
Foraminifera become important in rock making
Brachiopods still the dominant "shell fish"
Molluscs developing, the goniatites appaaring
Ancestral insects?
Fish still abundant but less varied. Sharks.
Salamander skeletons present, also footprints
Land plants abundant, but fragmentary. Probably like Pennsylvanian

Pennsylvanian -- land forms abundant
Insects appear in great abundance
Cockroaches
Ancestral dragonflies of large size
" bugs
" grasshoppers
Scorpions, spiders,
Land snails rare
Fresh water clams
Ganoid fish abundant
Amphibia "
Rare reptilian remains occur
Coal flora dominant (many plants attaining large size) and widespread
Spore-bearing trees
Large ferns common
Horsetails of giant size
Scale trees abundant
Seed ferns abundant (possible ancestors of other seed-bearing plants)
Ancestral conifers present
Marine life abundant:
Lacy Bryozoa, Foraminifera, Pelecypods and gastropods
goniatites begoming diversified
Corals few, crinoids and sea urchins fragmentary, ostracods continue

Permian -- seasonal climatic changes become evident
Swamp flora gave way to plants capable of withstanding dry climate and seasonal change (tree rings become evident)
conifers increase; large pteridophytes (spore-bearers) decrease
Glossopteris flora abundant in southern hemisphere (seed ferns with small, thick leaves)
Insects abundant but smaller than those of Pennsylvanian
Mayflies common; true dragonflies appear; ancestors of wasps and bees occur; true bugs appear; and late in period the beetles.
Among the Amphibia, the Stegocephalians continue (short-legged, heavy armored)
Reptiles increased and diversified showing marked development over the Pennsylvanian. No modern orders occurred. All were 4-legged, mostly small (none over 10 ft); first mammal-like reptiles (Therapsida)
Marine life -- ammonites developing
Other molluscs (pelecypods and gastropods) progressing
brachiopods abundant
trilobites died out, alos most crinoids and some coral and bryozoa

MESOZOIC

Triassic

Chief groups of Paleozoic plants extinct, or nearly so

Seed ferns nearly gone and club mosses known only from a few Sigillaria.

Forests largely of conifers and cycads (sago palms), with undergrowth of true ferns, tree fers, and scouring rushes

Extinction of giant spore-bearers (clubmosses and horsetails) and primitive seed-bearers (seed ferns)

Stegocephs attained culm nation in size and variety, but surpassed by reptiles, which were becoming adapted to all conditions of life on land and even to invade the sea, competing with fishes. Phytosaurs in streams bones associated with river clams and lungfishes (no phytosaurs in any period but the Triassic. Ichthyosaurs in late Trias. seas, also plesiosaurs

Dinosaurs made appearance and became dominant land type. Characterized by carrying body off the ground, adapted for running. Triassic dinosaurs slender and relatively small (10-15 feet at most). Most Trias. forms wer bipedal.

Other reptiles included several orders of primitive types, squatty and heavioy built. Also theriodont reptiles leading to mammals.

First true mammals, small and rare

Marine life -- ammonites became abundant and diversified. But nearly died out at end of Trias. Squid-like cephalopods appeared early in Trias. Clams and gastropods ascending. Modern types of echinoids and starfish and small lobsters originated at this time.
Reef-building corals similar to living types appear in late Trias.
Brachiopods on the decline

Wide-spread aridity characterized the Triassic. No glaciation
Land emergent no inland seas. Decline of temperature toward end of period

Jurassic

Inland seas again forming (except in North America). Climate humid and warm.over most of the earth.

Plants of the ever-green type still dominant, conifers, gingkos, tree ferns, rushes
Primitive flowering plants, but not true angiosperms.
Cycads abundant

Insects very abundant in the Jurassic. True flies appear, also scorpion-flies, caddis flies, grasshoppers and first moths. Ants present.

Reptiles now in full sway, dominating land, air and sea

First evidence of feathered forms occur (Archaeopteryx)

Mammals continue to be of small size.

Marine invertebrates resembling modern fauna -- modern reef corals, clams and snails resembled modern forms. True oysters common, abundant lobsters and shriplie crustaceans. Sea urchins of modern type.
Ammonites held through Jurassic attaining great variety and intricasy.

Insects and related forms
(first appearance of groups)

Silurian -- Millipedes

Devonian -- Sowbugs

Lower Missippian -- Ancestral insects

Pennsylvanian -- lst winged forms-- ~~most modern orders~~ begin
Cockroaches, ancestral dragonflies, ancestral bugs, anc. grasshoppers
Centipedes

Lower Permian -- Scorpion flies, true dragon flies, mayflies, true bugs

Upper Permian -- beetles, lacewings

Triassic, a-- ancestral caddice flies

Jurassic -- true flies, caddice flies, grasshoppers
first appearance of lepidoptera (moth)

Cretaceous -- wasps

Eocene -- Butterfliesand moths, fleas, termites

From Wilson, H.F. and Doner, MH. Historical development of insect classification. Dept. Economic Entomology, Univ. of Wisconsin, 1937 p. 107.

Gradual emergence of western N. Amer. and building of Cascades and Sierra Nevadas. Spermatophytes dominant. Gymnospers: conifers; but

Cenozoic

Angiosperms dominant

EOCENE

Plant genera largely limited (now) to low latitudes

Palm, fig, avocado, cinnamon, magnolia.

Indicate warm, moist climate as far north as Oregon and Washington

Forest essentially modern ~~with~~ continuing process begun in Cretaceous

~~Herbaceous plants and grasses not preserved~~

Invertebrates of sea mainly of modern type. ~~Change~~ Modern genera and even species appearing.

Ammonites and Belemnites entirely extinct

Nummulites Foraminifera characteristic.

Land life. Amphibia and Reptiles the ~~main~~ types existent today. Dinosaurs extinct. Most modern orders of birds present. Toothed types extinct.

First radiation of mammals: marsupials, insectivores, archaic carnivores (Creodonta); archaic herbivores both heavy (amblypods) and slender (Condylarths) in ~~Basal~~ Ex Paleocene. In the Eocene proper ancestors of modern mammals appeared and archaic ~~forms died out~~ became ~~extinct~~ declined

Eohippus, hornless rhinoceroses, small titanotheres, tiny cmeloids, oreodonts, squirrel-like rodents, monkeys.

MIOCENE

Typical genera of temperate climate. Arid conditions, spread of pariries

Redwood, alder, maple, oak, walnut, beech, chestnut, basswood, elm

Indicate mild, moist climate like that of coast of northern Calif.

Though grasses not preserved, trend of mammals to long-crowned teeth indicates first spread of prairies.

Invertebrates (marine) of modern type. ~~Change~~ Many modern species in existence.

Land life. "Golden Age of Mammals". Evolution of grazing animals. Increase in size of mammals. Horses, rhinos, oreodonts all common. Giant pigs reached climax. Old world ape (Dryopithecus) common in Europe and Southern Asia. Elephant-like beast reach N. Amer.

PLIOCENE

~~Stream-borders~~ types

Willow, poplar, sycamore. Reduction of forested areas and increase in grasslands.

Land life not well known as terrestrail formations poorly preserved. Many modern genera of birds present. First one-toed horses. Camels common even in Nn. Amer. Oreodonts become extingt toward close of epoch. Rhinos still abundant in n. Amer.

PLEISTOCENE

Modern species of pine, cypress, oak, hazel, manzanita, many ranging hundreds of miles south of they extent today. Indicate shift southward of north limits of forests of western America, because of progressive cooling and aridity.

Land-life. ~~Mammals~~ Many mammals of large size ("big game") all ofer the world, even Amer. Mammoths, groundsloths, large lions, wolves, camels.

First evidence of man

OLIGOCENE

Creodonts only remaining archaic mammal. Others of modern type.
Oreodonts in herds, 3-toed horses common. Rhinos still present in Amer.
Titanotheres increase to large size then die out. Camels, peccaries and tapirs present in Amer.
Beaver, squirrels, rabbits and mice.
Carnivores: small dogs and both biting and stabbing cats.
First proboscidea (small Mastodons in old world)
Primates extinct n N. Amer. Earliest ape appears in Europe (related to gibbon.

warm moist climate - palm trees & crocodiles found common in the Dakotas, Possibly seasonal inasfar. some it die / dwarfish at the Great Plains area of N. Amer. well timbered

Division	Examples	Characters	First appeared
SPERMATOPHYTA		SEED-BEARING	
Class Angiospermae		Flowering; seeds covered	Low.Cretaceous
Subclass Dicotyledonae	Oak, maple	Net-veined leaves floral parts in 4's or 5's	
Subclass Monocotyledonae	Palm, Yucca	Leaves parallel-veined. Floral parts in 3's	
Class Gymnospermae		Seeds naked. Leaves reduced to needles (usually)	
Order Coniferales	Pine, redwood, Araucaria	Seeds in cones; leaves needle or scale-like. Mostly evergreen	Carboniferous (anc. pine and Sequoia)
Order Ginkgoales	Ginkgo	Tree with broad, fern-like leaves primitive seeds	Triassic
Order Cycadales	Cycad (sago palm)	Palm-like leaves short trunk, large cones	Triassic (possibly in Permian)
*Order Cordaitales	*Cordaites (show relation to Coniferales and Cycadofilicales)	Large tree with strap-shaped leaf. Seeds in cones	Carboniferous (extinct Triass)
*Order Cycadofilicales	Seed ferns, Glossopteris	Fern-like leaves bearing seeds	Up.Devonian (died out Juras.) Glossopteris Permian.
PTERIDOPHYTA		SPORE-BEARING	
Class Filicinae			
Order Filicales	Ferns	Large, branched leaf (frond) bearing sporangia, usually not in cones.	Mid-Devonian
Class Equisetinae	Rushes.		
Order Equisetales	Horsetails, *Calamites	Stems jointed. Leaf scale-like, in whorls. Distinct cone.	Up.Devonian (Calamites ext. Permian)
*Order Sphenophyllales	Sphenophyllum	Stems jointed. Leaf wedge-shaped, in whorls. Cones.	Pennsylvanian (extinct by end of Paleozoic)
Class Lycopodinae			
Order Lycopodiales	Clubmosses. *Lepidodendron, *Sigillaria (Scale-trees)	Stem with small, spirally arranged leaves. Sporangia on leaves Usually grouped in cones.	Up. Silurian? (Dominant in Carbonif., large ones ext.end Perm.)
*Class Psilophytinae	Psilophyton	Rootless. Stems smooth or spine-covered. Simple sporaggia	Low.Devonian (only?)
*Order Psilophytales	Rhynia, Asteroxylon		

Compiled from Chaney's Syllabus & Schuchert & Dunbar

Division	Example	Characters	First appeared
BRYOPHYTA		Simple, leaf-bearing stem. Spores.	
Class Hepaticae	Liverworts		
Class Musci	Mosses		
THALLOPHYTA		Simple plants of: 1 cell, or filament, or gropp of cells Usually no differentiation of stem, root and leaf	
Class Fungi	Mushrooms, molds, mildews		
Class Algae	Sea weeds, pond scumm.	Soft except some cause calcareous precipitate.	Proterozoic
	Diatoms, nullipores	Calcareous or siliceous shells or supports	
	Bacteria		

Other names for the phyla listed

Cret. ANGIOSPERMOPHYTA -- Spermatophytes, flowering plants, hardwood trees, etc.
Carboniy. CONIFEROPHYTA -- Gymnospermae, conifers, ginkgo, Cordaites only.
Trias. o Penn. CYCADOPHYTA -- Here separate phylum from Gymnospermae (sago palms)
up. Devon. PTERIDOSPERMOPHYTA -- Seed Ferns, here separate from Gymnospermae
up. Silur. LEPIDOPHYTA -- Club mosses, here separate from Pteridophyta or ferns
up. Devon. ARTHROPHYTA -- Class Equisetales Scouring rushes or horsetails, here separate from Pteridophyta †Sphenophyllum
Mid- Devon. PTERIDOPHYTA -- Ferns only
? BRYOPHYTA -- Mosses and liverworts
Proterozoic? THALLOPHYTA -- bacteria, fungi, seaweeds

MOLLUSCA

Class Amphineura	
Order Aplacophora	
Order Polyplacophora (Chitons)	Ordovician - Recent
Class Scaphopoda (tooth shells)	Devonian - Recent
Class Gastropoda	
Order Prosobranchiata (not coiled)	Cambrian - Recent
Order Opisthobranchiata " "	Cambrian - Recent
Order Pulmonata (snails and slugs)	Devonian - Recent
Class Pelecypoda mussels	
Order Prionodesmacea (oysters, pectens)	Ordovician - Recent
Order Teleodesmacea (clams)	Devonian - Recent
Order Anomalodesmacea	Silurian - Recent
Class Cephalopoda	
Order Tetrabranchia	
*Suborder Ammonidea	Silurian - Cretaceous
Suborder Nautiloidea	Ordovician - Recent
Order Dibranchia	
Order Decapoda (Belemnites, etc.)	Triassic-Cret. (Recent)
Order Octopoda (devilfish)	Cretaceous - Recent

Storer, pp. 409-411

ECHINODERMATA

Subphylum Pelmatozoa (calyx on a stalk)	
*Class Cystoidea	Cambrian -Carbonif.
*Class Blastoidea	Ordovician -Permian
Class Crinoidea (Sea lilies)	Ordovic.-Recent
Subphylum Eleutherozoa (no stalk or cirri	
Class Asteriodea (Starfishes)	Ordovic.-Recent
Class Ophiuroidea (Brittle Stars)	Mississ.- Recent
Class Echinoidea (Sea urchins,etc.)	Ordovic.-Recent
Class Holothurioidea (Sea cucumbers)	Cambrian?-Recent

COELENTERATA

Class Hydrozoa	Mid.Cambrian-Recent
Order Hydrocorallina (Polyps minute, protruding through massive calcareous skeleton)	Triassic-Recent
	(Graptolites)
Order Hydroida	Mid.Cambrian forms here? /
Order Trachylina	
Order Siphonophora	
Class Scyphozoa (Jelly-fish)	Low.Camb.-Recent
C 4 orders	
Class Anthozoa (Corals, sea anemones)	single,non-calc. sp. Mid-Cambrian
Subclass Alcyonaria (colonial; 8 tentacles)	
Subclass Zoantharia(sea anemene; stony corals	Pre-Cambrian? -Rec.

ARTHROPODA	
Class Crustacea	
Subclass Branchiopoda (shrimps, etc.)	Cambrian-Recent
Subclass Ostracoda	Ordovician-Redent
Subclass Copepoda	
Subclass Cirripedia (Barnacles)	Ordovician-Recent
Subclass Malacostraca (Lobsters, crayfish, etc.)	
Series Leptostraca (Bi-valved carapace)	Cambrian-Recent
Series Eumalacostraca	
Order Mysidacea (Opossum shrimps)	Carbonif.-Recent
Order Isopoda (Sowbugs)	Devonian -Recent
Order Amphipoda	Tertiary-Recent
Order Stomatopoda	Carbonif.-Recent
Order Decapoda	Triassic-Recent
3 other orders	No fossils
* Class Trilobita	Cambrian - Permian
Class Insecta	
Subclass Apterygota (No wings; no metamorphosis)	
(Springtails, Bristails and 1 other order)	Eocene-Recent
Subclass Pterygota (winged)	
*Order Protoephemerida (ancestral may flies)	Low.Mississippian
*Order Protodonata (ancestral dragon-flies)	Pennsylvanian
*Order Paleodictioptera (ances. to most orders?)	Carboniferous (Miss.?)
*Order Synarmogoidea	Low.Mississippian
**Order Protoblattoidea (ances. beetles)	Pennsylvanian
*Order Protorthoptera (ances. grasshoppers)	Pennsylvanian
*Order Protohemiptera ((ances. bugs)	Pennsylvanian
*Order Megasecoptera (ances.flies, etc.)	Pennsylvanian
—Order Blattaria (Cockroaches)	Pennsylvanian - Recent
*Order Protohymenoptera (ances. ants,wasps,bees)	Low. Permian
—Order Corrodentia (book lice)	Low. Permian - Recent
—Order Hemiptera (true bugs)	Low.Permian - Recent
—Order Ephemerida (true may flies)	Low Permian - Recent
—Order Odonata (true dragon flies)	Low. Permian - Recent
✓Order Mecoptera (scorpion flies)	Low. Permian- Recent
✓*Order Protocoleoptera (ances. beetles)	Up. Permian
✓Order Coleoptera (true beetles)	Up. Permian -Recent
✓Order Neuroptera (ant lions, dobson flies)	Up. Permian -Recent
*Order Paratrichoptera (ances. caddis flies)	Triassic
✓Order Diptera (true flies)	Jurassic-Recent
✓Order Trichoptera (true caddis flies)	Jurassic-Recent
Order Saltatoria (true grassoppers)	Jurassic-Recent
✓Order Lepidoptera (moths,butterflies)	Jurassic or Eocene-Rec.
✓Order Hymenoptera (ants, Wasps, bees)	Jurassic Cretaceous (wasp)-Rec.
✓Order Siphonaptera (fleas)	Eocene-Recent
✓Order Strepsiptera (stylops)	Eocene-Recent
—Order Thysanoptera (thrips)	Eocene-Recent
—Order Dermaptera (earwigs)	Eocene-Recent
—Order Isoptera (termites)	Eocene-Recent
—Order Embioptera (embiida)	Eocene-Recent
—Order Homoptera (aphids, scale insects)	Jurassic-Recent
—Order Mallophaga (biting lice)	
—Order Mantodea (Mantids)	Permian-Recent
—Order Phasmida (Walking sticks)	Jurassic-Recent
Order Suctoria	Eocene-Recent

— = incomplete metamorphosis
✓ = complete "

Wilson and Doner pp. 94 and 107
Storer pp. 487-510 and 456-458

ARTHROPODA continued

Class Arachnoidea	
Subclass Merostomata	
Order Xiphosura (king crabs)	
*Order Eurypterida	Cambrian-Carboniferous
Subclass Arachnida	
Order Scorpionida (Scorpions)	Silurian-Recent
Order Pedipalpi (Whip scorpions)	Carboniferous-Recent
Order Palpigrada	
Order Araneida (Spiders)	Carboniferous-Recent
Order Solpugida (Vinegarones)	Carboniferous-Recent
Order Pseudoscorpionida (False Scorpions)	Tertiary-Recent
Order Podogona	Carboniferous-Recent
Order Phalangida (daddy longlegs)	Carboniferous-Recent
Order Acarina (mites, ticks)	Oligocene-Recent
Class Chilopoda (centipedes)	Up. Pennsylvanian? (Wilson & Doner)
Class Diplopoda (millipedes)	Silurian (W and D)
Class Onychophora ("walking worms")	Pre-cambrian? Recent
Class? Pycnogonida (Sea spiders)	Devonian-Recent
" Pentastomida (Linguatulida) and 3 others	No fossils

Storer pp.525-529
Wilson and Doner p. 107

CHORDATA

Acrania
Subphylum Hemichordata (Notochord short, ant; nerve tissues in skin)
Class Enteropneusta (tongue worms)
Class Pterobranchia
Subphylum Tunicata (notochord and nerve cord in larva only)
Class Larvacea
Class Ascidiacea
Class Thaliacea
Subphylum Cephalochordata (Notochord and nerve cord long, and persistent)
Class Leptocardii (Lancelets -- amphioxus)

Craniata
Subphylum Agnatha (no true jaws)
Superclass Pisces (paired fins, gills, and scales)
*Class Aphetohyoidea (Arthrodires, armered head jointed to armored thorax)

Class Chondrichthyes (sharks and rays)

Class Osteichthyes (bony fishes)

~~Su~~

Craniata
Subphylum Agnatha
*Class Ostracodermi (Anc. Armored fish) Ordovician - Devonian

Class Cyclostomata

Subphylum Gnathostoma
Superclass Pisces
*Class Aphetohyoidea (Arthrodires) Silurian - Permian

Class Chondrichthyes (Elasmobranchs) (Carbonif.-Recent)
3 extinct, 1 living order Devonian-Permian ~~(Rec)~~
Class Osteichthyes (Teleosts)

Superclass Tetrapoda
Class Amphibia
Class Reptilia
Class Aves
Class Mammalia

MAMMALS

Subclass Prototheria		
Order Monotremata	Egg-laying	No sure fossils
*Subclass Allotheria		
*Order Multituberculata		Triassic to Eocene
*Order Triconodonta (in this subclass?)		Jurassic
Subclass Theria		
*Infraclass Pantotheria (possibly ances. to Marsupials)		
*Order Symmetrodonta (Tritubersulata)		Jurassic
*Order Pantotheria (Tritubersulata)		Jurassic
Infraclass Metatheria		
Order Marsupialia		Cretaceous to Recent
Polyprotodonts (Opossums; carnivorous forms)		Cretaceous to Recent
Diprotodonts		Pleistocene?
Caenolestoids		Eocene of So.Amer.
Infraclass Eutheria		
Order Insectivora (from main primitive stem)		Cretaceous to Recent
*Order Tillodontia (off-shoot)		Eocene
Order Dermoptera (from insectivore stem)		No fossils
Order Chiroptera (" " ")		Eocene to Recent
*Order Taeniodontia (Off-shoot)		Paleocene, Eocene
Order Primates (from insectivore stem)		Paleocene to Recent
Order Edentata		Eocene to Recent
OrderRodentia		Eocene to Recent
Order Carnivora		Paleocene to Recetn
Order Cetacea		Eocene to Recent
*Order Condylarthra (Possibly to Perissodact.)		Paleocene, Eocene
Order Tubulidentata		No fossils
*Order Amblypoda (anc. Proboscidea,Siren.,Hyrac.?)		Paleocene-Oligocene
*Order Dinocerata		Eocene
*Order Notoungulata (separate shoot)		Paleocene-Pleistocene
*Order Pyrotheria		Eocene-Oligocene
*Order Litopterna		Eocene-Pleistocene
Order Proboscidea		Eocene-Recent
*Order Barytheria		Eocene
Order Sirenia		Eocene-Recent
*Order Embrithopoda		Oligocene
Order Perissodactyla		Eocene-Recent
Order Artiodactyla		Eocene-Recent
Order Hyracoidea		Oligocene-Recent

Romer p. 269
Storer, pp. 706-721

SUBPHYLUM GNATHOSTOMA

Superclass Pisces	
*Class Aphetohyoidea	
*Order Acanthodii (ganoid-like, with dermal armor)	Silurian-Permian
*Order Placodermi (Arthrodires)	
Class Chondrichthyes (Elasmobranchii)	
*Order Cladoselachii	Devonian-Carbonif.
*Order Pleuracanthodii	Devonian-Permian
*Order Stegoselachii	Devonain-Carbonif.
Order Selachii	
Suborder Squali (Sharks)	Carbonif.-Recent
Suborder Batoidea (Rays)	Triassic -Recent
*Order Bradodonti	Devonian-Permian
Order Holocephali (Chimaeras)	Triassic-Recent
Class Osteichthyes (Pisces)	
Subclass Palaeopterygii (ancietn fishes)	
*Order Archistia (body with ganoid-scales)	Low.Devonian-Juras.
Order Cladistia (lung-like air-bladder)	Paleozoic and Rec.
Order Chondrostei (Sturgeons)	Low.Juras.-Recent
*Order Belonorhynchii	Low Juras.-Triassic
Subclass Neopterygii (Modern Fishes)	
*Order Protospondyli (large air bladder)	UP.Juras-Low.Tert.(Rec.
Order Ginglymodi (Gar pikes)	Eocene-Recent
Superorder Teleostii (Bony fishes)	
*Order Halecostomi	Mesozoic
Order Isospondyli (Herring,salmon,trour	Juras.-Recent
Order Haplomi (Pikes and mud minnows	Miocene-Recent
Order Iniomi (Lant rn fishes	Cret.-Recent
Order Giganturoidea	
Order Lyomeri (Gulpers)	
Order Ostariophysi (Catfish, suckers)	Eocene-Recent
Order Apodes (eels)	Cret.-Recent
Order Heteromi	
Order Synentognathi (Flying fish	
Order Microcyprini	
Order salmopercae (trout-perch)	
Order Solenichthyes (Pipefish and sea horses)	
Order Anacanthini (Cods, etc.)	
Order Allotriognathi (opah)	
Order Percomorphi (Perch, mackerel, barracuda,smelts)	
Order Scleroparei (Bass, Sculpins)	
Order Heterosomata (Flatfish)	Up. Eocene-Rec.
and other orders without fossils	
Su	
Subclass Crossopterygii (anc. to Amphibia etc.?)	
*Order Rhipidistia (Lobe-fins;ganoids)	Devonian-Carbon.
Order Actinistia	Mississ.-Cret (Rec.)
Dipneusti (Dipnoi, lungfish)	Devonian-Recent

Divisions	Characteristics	Fossil occurrence
AMPHIBIA		
Subclass Stegocephalia	Cranium and cheeks roofed with bony plates; often armored ventrally, some dorsally.	
*Order Leptospondyli	Small, salamander-like	Carbonif.-Permian
*Order Phyllospondylii	" " "	Devonian.-Permian
(Branchiosaurs) ANCESTRAL STOCK to modern types?		
*Order Labyrinthodonti	Small to large, salamander or crocodile like. Usually armored with dermal plates	Low. Carboniferous to Up. Triassic
Order Gymnophiona (Apoda)	Slender, worm-like body, no limbs	No fossils
Subclass Caudata (Urodela) (salamander, newts	Body elongate. Larvae and adults similar in form	Cretaceous to Recent
Order Proteida	Permanently aquatic. Gills permanent. (Water-dogs)	
Order Mutabilia	Lungs in adult (True Salamanders)	Miocene Andrias
Order Meantes		
Subclass Salientia (Anura) (frogs and toads)	Head and trunk fused, no neck or tail in adult	Jurassic to Recent
Order Amphicoela (Bell toads)		
Order Opisthocoela (toads)		Up.Miocene(Laonia)
Order Anomocoela (Spadefoot toad)		
Order Procoela (True toads and a fossil)		Juras.-Miocene (Palaeobathrachia)
Order Diplasiocoela (Ranidae) (true frogs) tree frogs and "narrow-mouthed toads")		

Romer p. 107
Storer pp. 604-610

REPTILES

Subclass Anapsida	
*Order Cotylosauria (stem reptiles)	Permian Seymouria
Order Chelonia (turtles) (from Cotylosaurs?)	Permian Eunotosaurus; Cret. Archelon
*Subclass Ichthyopterygia	
*Ichthyosauria (marine forms)	Triassic-Cretaceous
*Subclass Synaptosauria	
*Order Sauropterygia (Plesiosaurs) (Marine)	Jurassic-Cretaceous
Subclass Lepidosauria	
*Order Eosuchia (Ancient forms)(from Cotylosaurs?)	Up. Permian-Jurassic
Order Rhynchocephalia (Sphenodon living)	Triassic to Recent
Order Squamata (lizards, mosasaurs, snakes)	
*Mosasaurs	Cretaceous
Lizards	Jurassic to Recent
Snakes	Cretaceous to Recent
Subclass Archosauria (Dinosaurs, etc. and modern Alligators)(from Eosuchia?)	
*Order Thecodontia (Phytosaurs)(ances. to others?)	Triassic
Order Loricata (alligators, etc.)(from Thecodonts?)	Jurassic to Recent
*Order Pterosauria (Flying reptiles)(" ")	Jurassic-Cretaceous
*Order Saurischia (Reptile-like Dinosaurs)(" ")	
Theropoda (bipeds)	Jurassic Compsognathus Cret. Tyrannosaurus
Sauropoda (Quadrupeds)	Jurassic Brontosaurus
*Order Ornithischia (Bird-like Dinosaurs)	
Ornithopoda (Duck-bills) (Bipeds)	Jurassic-Cretaceous
Stegosauria	Jurassic
Ankylosauria (Armored dinosaurs)	Cretaceous
Ceratopsia (Horned Dinosaurs	Cretaceous
*Subclass Synapsida (Mammal-like forms)	
*Order Pelycosauria	Permian and Carbonif.
*Order Therapsida (Mammal-like reptiles)	Permian and Triassic (Cynognathus)

Romer pp. 127 and 179
Storer pp.632

Introduction

Paleontology is the science which treats of ancient life. As ~~this science~~ is necessarily based upon the study of remains of animals long since deceased, it has been commonly looked upon as in itself a dead subject. However, correctly interpreted, paleontology is very much concerned with life -- the history of life and the ancestors of the living forms we know today.

Man has always been interested in knowing ~~something~~ about the past. Some are concerned only with the immediate ancestors, with the pioneer grandmother who came across country in a covered wagon. Others have an intense interest in historic records and what they reveal of the early life of our country, or of other countries. Still others are thrilled with the stories of ancient Egypt or Peru as revealed by archaeological finds. The paleontologist finds equally intriguing the scenes of still earlier life on the earth which can be reconstructed from fossils -- that is, from the remains or traces of animals and plants which have lived in a geologic age prior to the one in which we now find ourselves.

When we concern ourselves with events prior to those of historic record, we no longer attempt to estimate time by years, but rather by geologic ages or periods. This measure of past time is based upon geologic events rather than upon the ~~earth's~~ yearly orbit of the earth about the sun, and is known as the geologic time scale. It has been gradually constructed as more knowledge of ancient rock formations and fossil faunas has been amassed. The scale shown in the following table is the result of years of study ~~on the part of scientists~~. The duration of the various divisions, given in terms of years, is purely an estimate on the basis of various criteria, and is presented only for the purpose of illustrating the great expanse of time represented as contrasted with the historic record.

ERAS	PERIODS	EPOCHS	DOMINANT LIFE
Cenozoic (duration 60,000,000 years)	Quaternary	Recent Pleistocene	Man
	Tertiary	Pliocene Miocene Oligocene Eocene	Mammals and Birds
Mesozoic (duration 140,000,000 years)	Cretaceous Jurassic Triassic		Reptiles (first birds and mammals)
Paleozoic (duration 410,000,000 years	Permian Carboniferous Devonian Silurian Ordovician Cambrian		Amphibians Fishes Higher Invertebrates
Proterozoic			Lower Invertebrates
Archeozoic (duration of the two together 700,000,000 years)			Unicellular forms

We note that the age in which we live -- the Recent -- is listed as an epoch of the Quaternary period. The beginning of the Recent is calculated to have been about 20,000 years ago, at the recession of the last glaciation. The paleontologist's study, therefore, begins several centuries before the first written records of history, and goes back into the dawn of life.

The fossils with which the paleontologist works are the remains, or sometimes only the traces -- such as footprints or the droppings of an animal, or the impression of a leaf -- of the life which inhabited the earth during these earlier periods, from the Pleistocene back. But bit by bit the accumulated evidence presents a picture of the changing forms which have inhabited the earth.

The most common parts of organisms to be preserved as fossils are the hard parts -- the bones of vertebrates, the shells of shellfish, the woody part of plants. These, by reason of their greater density, are better able to resist disintegration than are the softer parts. The prime essential in the preservation of organisms as fossils is protection from erosion and disintegration, which, of course entails burial or entombment of some kind. It is clear therefore, that the vast majority of creatures which have lived will never be found as fossils. When an animal dies it is usually left exposed upon the ground, the flesh decays or is devoured by predatores, and the wind, rain and sun finally complete the destruction. It is only those carcasses which are covered over in some manner which are preserved. Thus we must search for fossils in rocks formed originally by the deposition of sediments in the ocean or in lakes or rivers. There are various ways in which this has been accomplished.

(1)Chief among these is burial in the sediments of lakes, rivers or the ocean. Not only do these sediments serve as a protection from weathering, but in certain instances the infiltration of ground water into the bone or shell gradually replaces the organic matter, molecule by molecule, until the original organic matter is literally "turned to stone". This process is known as petrifaction. Though petrified fossils are the most common, fossils are by no means always petrified. In some instances the organic matter decays out leaving a perfect impression or mold, which may in turn be filled with sediments which, as they harden into rock, take on the exact shape of the mold, thus producing a perfect cast of the organism.

Less frequent types of burial or entombment are:

1. Burial in caves. Animals may have their dens in caves and die there, they may drag in the carcasses of other animals, or again individuals may fall through fissures. In dry caves, protected from weathering by the shelter of the cave, and from decay by the absence of bacteria, carcasses may be preserved over long periods, sometimes becoming partially mummified, so that the dried skin and hair remains adhering to the articulated skeleton. In fissures, animals may be buried in the accumulating rubbish and sealed in as the fissure continues to fill in with wind or water borne sediments.

2. In the arctic regions of Siberia and Alaska the frozen carcasses of Pleistocene mammals have been found in the frozen soil of the deltas of rivers which enter the Arctic sea. The animals must either have been drowned or bogged down during the short time in the summer when the tundra melts and the overflowing rivers spread mud and silt out over it. This type of preservation is exceedingly rare, and especially valuable, as not only the skeleton, but the skin and hiar and much of the soft anatomy are preserved.

3. Miring in peat bogs, swamps and asphalt is another manner in which prehistoric animals have been preserved as fossils. Of particular interest in this regard are the asphalt deposits in southern California, from which half a million bones of birds and mammals were recovered. The soft parts have disintegrated, but the bones, thoroughly impregnated with tar have been preserved without chemical change.

4. Footprints. Just as today a bird walking across a mud flat leaves its foot prints, birds of prehistoric days did likewise. Where hardening mud preserves their shape and other deposits of sand and silt have accumulated to cover them over, they sometimes remain through the ages to be later discovered by man.

See next page

Just as it is a matter of chance that some individuals die under conditions which favor their survival as fossils, it is also a matter of chance that the fossil should be found by man. Elevation of the land from beneath the sea has raised many deposits within the reach of man, but only a few are exposed on the surface today. It is often through excavation of roads or tunnels that fossils come to light and their discovery is reported to paleontologists who can understand their full significance. And so it is by a rare combination of chance circumstances that modern man is learning the history of life. Little wonder then that so many links in the chain are missing, it is rather to be marvelled at that so much has already been learned.

As the science of paleontology has developed, specialization in one group or another has occurred, until we now have almost as many branches as there are groups. Avian Paleontology, then is one of these many branches, the branch which deals with ancient bird life.

Fossil birds are less well known than fossil mammals, which latter have been studied in great detail with the ancestry of many types being well represented in the fossil record. Due to the fragility of the bones of birds, however, their remains are less often preserved, and those which are do not tell the story as clearly as do the mammal bones. There is no one part of the bird which is usually preserved and which is particularly diagnostic, as with the skull and teeth of mammals. In the study of fossil birds, therefore, it is often difficult to correlate one discovery with another because of the lack of similar elemtnts of the skeleton. The avian fossil record, therefore is intermittent and there are no spectacular evolutionary series as in the mammals.

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~~to be discoverd later by man.~~

Just as it is a matter of chance that some individuals die under conditions which favor their survival as fossils, it is also a matter of chance ~~that~~ when the fossils ~~should~~ are found by man. Elevation of the land ~~from beneath~~ the sea has ~~raised~~ brought many ~~deposits~~ early deposits within the reach of man, folding or recession though ~~the great mass of ancient rock is still~~ thousands of feet beneath the surface, ~~but only a few are actually on the surface today~~. It is often only through excavation of roads or tunnels that fossils come to light and their discovery is reported to paleontologists who can understand their full significance. And so it is by a rare combination of chance circumstances that modern man is learning the history of life. Little wonder that so many links in the chain are missing.

As the science of paleontology has developed, specialization in one group of organisms or another has occurred, until we now have almost as many branches of paleontology as of zoology. Avian paleontology with which we are primarily to be concerned here, is one of these branches, the branch dealing with ancient bird life.

As the science of paleontology has developed, specialization in one group of organisms or another has occurred, until we now have almost as many branches of paleontology as there are groups. Avian Paleontology is one of these many branches, the branch which deals with ancient bird life.

Compared with the amount of time which is estimated to have elapsed since life began on the earth, birds have had a very short span. Their earliest record is found in rocks of Jurassic age, at which time we find them to have been lacking in the special adaptations for flight which are characteristic of modern birds.

Avian fossils are comparatively rare. In contrast with the 2300 species of fossil mammals recorded from North America alone, there are roughly only 1300 species of fossil birds known from the whole world, with fewer than four hundred from North America.

In a few instances, footprints of birds or feather impressions have contributed to the avian fossil record, slightly more frequently fragments of egg shell have been discovered, but the majority of specimens have been of skeletal elements. Due to the fragility of the bones of birds, they do not preserve as well as the bones of mammals, nor is there any one part of the skeleton which is sturdier than the rest or which is particularly diagnostic, as is the case with the skull and teeth of mammals. In the study of fossil birds, therefore, it is often difficult to correlate one discovery with another because of the lack of similar elements of the skeleton.

Within the United States, California represents the area richest in fossil birds. One hundred and seventy-six species are listed from twenty five localities in California. These species are from the late Tertiary and the Pleistocene. They include, of course, the three great Pleistocene asphalt deposits from which more individual bird bones were taken, probably, than from all the other fossil bird localities put together. Less abundant, though of perhaps greater significance are the Cretaceous birds of Kansas. These species, ten in number, are the oldest birds known in North America, and show certain very primitive characters which have been lost in the modern birds. The accompanying table shows the number of localities from which fossil birds have been reported in North America, together with the number of species from each state and the geologic periods represented.

Altogether from North America there have been recorded 380 species of fossil birds, from 122 different localities. The same species, of course are frequently found at more than one locality. The accompanying table shows the number of fossil localities from which fossil birds have been reported, by states. The number of species identified in each case is given, as well as the geologic ages represented

State	localities	species	periods represented
Arizona	1	5	Upper Pliocene
Arkansas	1	1	Pleistocene
California	25	176+	Miocene, Pliocene, Pleistocene
North Carolina	1	2	Miocene
South "	1	1	Miocene
Colorado	4	9	Eocene, Oligocene, Miocene
Florida	9	68	Pleistocene
Idaho	3	9	Upper Pliocene, Pleistocene
Illinois	1	3	Late Pleistocene
Kansas	10	15	Cretaceous, Miocene, Pliocene
Maine	1	1	Pleistocene
Maryland	2	7	Miocene, Pleistocene
Mississippi	1	1	Eocene
Montana	3	3	Cretaceous, Miocene
Nebraska	11	13	Oligocene, Miocene, Pliocene, Pleisto
Nevada	4	8	Miocene, Pliocene, Quaternary
New Jersey	6 or 7	15	Eocene, Miocene, (Pleistocene) Quat.
New Mexico	5	61	" "(or Pliocene?) Quaternary
Oregon	4	7	Eocene Oligocene, Pleistocene
Pennsylvania	2	3	Pleistocnene
South Dakota	3	6	Oligocene, Pliocene
Tennessee	1	1	Pleistocene
Texas	5	6	Cretaceous, Pliocene, Pleistocene
Wyoming	17	32	Cretaceous, Eocene, Oligocene, Pleis
Utah	2	4	Eocene

California is in the lead both in number of localities and number of species. Also the most important fossil bird localities are found in this state, the asphalt deposits of Rancho La Brea, McKittrick and Carpinteria. From Rancho La Brea alone, there were more than eighty thousand bird bones recovered, representing over four thousand individual birds.

Oregon, is probably next in line of importance for, though there are only four fossil bird localities known there, the

#5

Zoological Classification

In order properly to appreciate the significance of fossils, it is necessary to understand something of the relationships of living forms. Though only a complex branching family tree could depict these relationships in detail, a satisfactory idea of the fundamental grouping can be obtained by a study of zoological classification, which as nearly as possible is based upon actual blood relationship.

The accompanying tables illustrate the general classification of the Animal Kingdom (Table 3) and the arrangement of orders of birds within the Class Aves (Table 4). Of these thirty-three orders of birds, twenty-seven are represented by living birds and six are known only from fossils. All but one of the existing orders have also fossil representatives. This is the order Coliiformes, an order containing a single genus and nine species all at present confined to Africa.

Each order of birds is further subdivided into families, the number of families per order varying from one to as many as sixty-five. The families in turn are subdivided into genera and the genera into species. The number of recorded species of birds is calculated at about 25,000, including both fossil and living forms.

According to the accpeted definition of a species, there is never a merging of one species with another. If two groups are found to overlap, they are considered to be merely races (subspecies) of the same species. In several groups, where, for example, a few individuals of group A resemble a few of those of group B, and still others of B resemble some of group C, yet none of A and C are alike, A, B, and C are all ranked as subspecies of one species. However, if anything should cause the extinction of B, the connecting link between A and C, the latter two forms would be considered separate species.

From this example, it is clear that many fossil forms must have supplied links of this sort relating one form to another. Thus, if we could

Table 3

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Plant Kingdom
Many divisions as with the Animal Kingdom.
Animal Kingdom
Subkingdom Protozoa -- unicellular animals
Phylum Protozoa
Subkingdom Metazoa -- multicellular animals
Phylum Porifera -- Sponges
Phylum Coelenterata -- Jellyfish and related forms
Phylum Ctenophora -- Combjellies
Phylum Platyhelminthes -- flatworms
Phylum Nemathelminthes -- roundworms
Phylum Molluscoidea -- lampshells and sea mosses
Phylum Echinodermata -- starfish, etc.
Phylum Annelida -- segmented worms (earthworms, etc.)
Phylum Mollusca -- clams, snails, etc.
Phylum Arthropoda -- insects, spiders, etc.
Phylum Chordata -- animals with back bone, or its first rudiment, the notochord.
Subphyla Hemichorda and Urochorda -- with notochord, but not backbone
Subphylum Vertebrata -- animals having a true back bone
Class Cyclostomata -- eel-like forms, with sucking mouth, and no jaws
Class Pisces -- fishes
Class Amphibia -- toads, frogs, and salamanders
Class Reptilia -- Lizards, turtles, snakes, alligators, etc.
Class Aves -- Birds, warm-blooded feathered creatures which lay eggs
Class Mammalia -- Mammals warm blooded haired animals which suckle their young.

use

Class Cyclostomata -- eel-like forms, with sucking mouth and no jaws and no paired limbs in form of fins
Class Pisces -- Fishes: jaws present, and paired limbs, br athe by means of gills, under water.
Class Amphibia -- Toads, frogs, salamanders: ~~breathe by means of gills under water in early stages, later by lungs, out of water, paired limbs fins~~ fish-like in larval stages, ~~adults developing lungs~~ and fins being transformed into terrestrial hand-like limbs, and lungs developed for air breathing in adults.
Class Reptilia -- Lizards, Turtles, snakes, alligators, etc.: Breathe by means of lungs, throughout life.
Class Aves -- ~~warm-blooded~~ Birds: Warm-blooded, feathered, and with fore limbs transformed into wings. Egg laying
Class Mammalia -- Mammals. Warm-blooded, forms with hair covering Suckle the young.

Classification of Birds

Class Aves
  Subclass Archaeornithes -- ancestral birds
   *Order Archaeopterygiformes -- Jurassic primitive ~~toothed~~ birds
  Subclass Neornithes -- true birds
   Superorder Odontognathae -- New World Toothed Birds
   *Order Hesperornithiformes
   *Order Ichthyornithiformes
   Superorder Palaeognathae -- struthious birds and allies
    Order Struthioniformes -- ostriches
    Order Rheiformes -- rheas
    Order Casuariiformes -- cassowaries and emus
   *Order Dinornithiformes -- moas
   *Order Aepyornithiformes -- elephant-birds
    Order Apterygiformes -- kiwis
    Order Tinamiformes -- tinamous
   [illegible]
   Superorder Neognathae -- typical birds
    Order Sphenisciformes -- penguins
    Order Gaviiformes -- loons
    Order Colymbiformes -- grebes
    Order Procellariiformes -- albatrosses, shearwater and petrels
    Order Pelecaniformes -- Tropic birds, pelicans, cormorants, etc.
    Order Ciconiiformes -- herons, storks, ibises, etc.
    Order Anseriformes -- ducks and geese
    Order Falconiformes -- vultures, hawks and falcons
   +Order Galliformes -- grouse, pheasants, etc.
    Order Gruiformes -- cranes, rails, etc.
   *Order Diatrymiformes -- Diatryma, etc.
    Order Charadriiformes -- shorebirds
   +Order Columbiformes -- pigeons and doves
   +Order Psittaciformes -- parrots
    Order Cuculiformes -- cuckoos
    Order Strigiformes -- owls
    Order Caprimulgiformes -- goatsuckers
    Order Micropodiformes -- swifts and hummingbirds
    Order Coliiformes -- colies (1 genus, 6 species)
    Order Trogoniformes -- trogons
    Order Coraciiformes -- kingfishers
    Order Piciformes -- Woodpeckers
    Order Passeriformes -- Perching birds

and attempt to include them all in a system of classification

know all of the forms which ever existed, it would likely be a difficult matter to draw the dividing lines, ~~for classification.~~ As there has been no regularity in the matter of extinction of ~~species~~ groups, the reason for the variability in number of families per order, or number of species per genus should be apparent. Also the farther back in time the link between two forms dropped out, the greater should be the differences between the living descendants. In this way may be explained the close similarity of the genera within one family and the wide differences between those of another.

To avoid confusion

Classification is based upon living forms. If a fossil is found which links two living species, it is given a distinct species name and considered to be an ancestral type. ~~Only in this way is it possible to avoid confusion.~~ Links of this sort which depend upon an overlapping of one species with another, and in which a fossil species is involved, are comparatively rare, largely because of the fact that fossils are seldom found in sufficient abundance to ascertain the variability of the species. Frequently fossil species are known from a single bone. Only in deposits such as those of the Rancho La Brea asphalt pits, where a species is represented by over a hundred specimens of one element of the sleleton, is it possible to observe the range of variation in a fossil species & not the relationships of the extremes of its range to one hope to find links between fossil and recent species. A case in point is the Rancho La Brea (Pleistocene) Caracara, a falcon-like bird whose variable characters overlap specimens of living Audubon Caracara, South American Caracho, and the recently extinct Guadalupe Island Caracara. He'd The R.L.B. bird lived contemporaneously with These & Thus, we might express The relationships superficially, instead, however all four main- Links between larger divisions are more readily observable, since a single individual may exhibit characters of both groups. The famous example of this sort among the birds is the most primitive bird known, which, though so well-preserved as to show the imprint of feathers, thus unmistakably avian, has skeletal characters, including teeth, and a long, lizard-like tail, similar to the reptiles.

Comparative Osteology -- Birds
vs. Reptiles and Mammals

Unfortunately the preservation of the feathers of fossil birds is exceedingly rare. This well-known characteristic of the class Aves, therefore, is practically useless to the paleornithologist. It is the more durable skeleton of the bird which is usually preserved and with which he must be thoroughly acquainted.

In general the skeleton of birds is characterized by its pneumaticity. The bones are thin-walled and light in weight, the limb bones hollow. In all birds some of the bones are air-filled and in some species the skeleton is completely pneumatic.

In addition to the lightness in weight, the bird skeleton shows other adaptations related to the habits of flight and bipedal terrestrial locomotion. These adaptations have to do primarily with the strengthening of the fore part of the skeleton to support the body in flight, or in a semi-upright posture on land. This strengthening is brought about by the enlargement of the breast bone (sternum) and the uniting with it of the elements of the shoulder girdle and the sternal ribs, the latter in turn connecting with the true ribs and thence with the vertebrae, forming a stout basket-like framework. In the typical flying birds the enlarged sternum is further characterized by a well-developed keel, extending along the center of the antero-ventral surface, to which are attached the strong pectoral muscles used in flying.

Basically, the skeletal structure of the wing in birds is not unlike the fore-limb of reptiles or mammals. (figures skeletons of bird & mammal labeled) The upper arm bone (humerus), two bones of the forearm (ulna and radius), wrist (carpal) and hand (metacarpal) elements, and the phalanges are all present though the carpals, metacappals and phalanges are reduced in number and modified in structure. Two of the carpals remain as separate elements, the others are fused together and unite with ~~three of~~ the metacarpals (reduced to three) to form the element known as the carpometacarpus, which is peculiar to the bird skeleton. (See figure). In very young birds the separate carpals and metacarpals are still evident. The reduction of the metacarpals also

each with a reduced number of phalanges
where only three digits are represented. The first has one, sliver-like phalanx, the second two (or rarely three) of which the first one is considerably broadened and flattened. The third digit, like the first, has but one phalanx.

The hind limbs show adaptations to a cursorial type of terrestrial locomotion in the uniting of three of the foot bones (metatarsals) into ~~a sort of~~ "cannon bone". The further union of these ~~metatarsals~~ bones with the distal ankle (tarsal) elements forms the element known as the tarsometatarsus, which like the carpometacarpus, is peculiar to birds. In appearance it has certain similarities to the cannon bone of ungulates (horses, deer, etc.) among the mammals, being a relatively long, straight bone, split ~~distally~~ into the separate condyles or trochleae for articulation with the toe bones. The bird tarsometatarsus, however, differs in its inclusion of the (tarsal) elements and in the fact that it is usually composed of three (metatarsals) which terminate in trochleae of uneven size and irregular position. The mammal cannon bone is composed of one or two metatarsals, the trochleae of the latter being identical. The bird leg is further modified by the union of the ~~proximal tarsals~~ with the ~~distal~~ end of the shin bone (tibia) to form the tibiotarsus. ~~The fibula is a small element attached to the tibiotarsus, the femur is unmodified.~~

A characteristic type of vertebra found only in birds, though not to the exclusion of other types, is that with the saddle-shaped centrum. In this type, the centrum, or central heavy portion of the vertebra, ~~ends anteriorly in an articulating surface which~~ is concave from side to side but slightly convex up and down, while ~~posteriorly the articulation~~ is just the reverse (convex from side to side and concave up and down). Other types of vertebrae include those in which the centrum is concave at both ends, and those in which one end is concave, the other convex. ~~Where the anterior~~ end is concave, the vertebra is procoelous, ~~posteriorly~~ concave it is opisthocoelous. The

vertebrae of reptiles are usually procoelous, those of mammals opisthocoelous. The fish represent the biconcave bype. Some of the early types of birds have this biconcave type also, while certain of the vertebrae in modern birds are opisthocoelous.

The skull of modern birds, is, of course, easily distinguished from that of either reptiles or mammals by the structure of the beak and the absence of teeth. It is further differentiated from the mammals by the articulation of the lower mandible with the quadrate, a separate bone common to both birds and reptiles, which is absent, or has been incorporated into the ear complex in mammals. The mammalian mandible articulates directly with the skull. The bird skull is also more delicately built than the mammal, and less compact. It differs from the reptilian skull largely in the greater development of the cranial portion and in the absence of fossae behind the orbits (though these fossae are not constant in all reptiles). The greater delicacy of the skull is notable in this comparison, also. The differentiation from the reptiles is clearly marked in some of the primitive birds. This subject will be given more detailed discussion under the Origin of Birds.

Comparative Osteology

Within the Class Aves

The distinguishing skeletal characters of the various divisions of the class Aves, though, of course, less outstanding than those which distinguish the birds from other classes of vertebrates, are noen the less discernible.

Within the superorder Paleognathae (sometimes referred to as the Ratites), which includes the ostriches and related forms, the birds are practically all flightless, cursorial types with flat, keelless sternum, reduced wing bones and well-developed tarsometatarsi. The ilium and ischium of the pelvis are unconnected, the coracoid and scapula are flattened and ~~xxxxxx~~ united by coossification end to end, rather than at the angle found in the other type of birds.

In the superorder Neognathae (or Carinates) which includes the typical flying birds, the sternum is keeled and the principal wing elements are present. The ilium and ischium meet posteriorly in adult birds, the coracoid is a rounder, more elongated bone with scapula united to it by a cartilage connection at a definite angle. The modifications of the tarsometatarsus are varied within this group, and in this element may be found many of the diagnostic characters of the families and even of the species. The Neognathae includes a few flightless forms, which show unmistakable derivation from flying types in the presence of the keeled sternum and unreduced wing elements. The latter show modification ~~by flattening~~, but are not reduced in number from the typical avian type.

Every skeletal element has characters which will assign it to its proper order, and ~~with the exception of~~ except with them a few groups, such as the shore birds and perching birds, to the family as well. Generic and specific characters, however, are less clearly marked and in certain of the living species, only ~~a comparison of the~~ the first metatarsal as compared with size of one element ~~with size of~~ another will separate the species. Instances of this nature are difficult to cope with in dealing with fossil remains, of course, for it is only rarely that associated skeletal elements are found. Fortunately, however, the great

mass of species are separable on the basis of ~~at least one or two~~ individual elements.

Of least value in identification are the ribs and vertebrae, and among the limb elements, the ulna, radius and fibula; in many cases ~~even these latter parts are~~ they may be completely useless. Of the more diagnostic elements, the tarsometatarsus and humerus are perhaps of greatest value to the paleontologist, both because they possess more distinguishing characteristics, and also because they are sturdy and thus better preserved than some of the other bones. Though the complete skull and lower mandible are diagnostic in recent species, it is extremely rare to find a complete specimen in a fossil state. The skull is particularly fragile and usually only the cranial portion is preserved, and this is surprisingly uncommunicative. Consequently the avian paleontologist finds nearly valueless the very element upon which the mammalian paleontologist bases the greater part of his conclusions. The sternum and pelvis are also susceptible to breakage, and show considerable individual variation of detail, so that though fairly diagnostic as to family or genus, they are seldom of value in specific identification.

To learn the distinguishing characters of the elements throughout the various groups of birds, it is necessary to have access to a good collection of bird skeletons and to study the actual specimens. Handling the bones themselves is the only way in which one may appreciate the subtleties of ~~difference~~ distinction, particularly as pertaining to species.

In general, however, ~~the differences may be found in one of the following characters. When all three can be used the identification is unquestionable.~~ The diagnostic features are found in one or all of the following characters.

1. Physical make up of the bone. The ~~differences in~~ nature and position of the processes and depressions on a bone, and ~~its~~ the general configuration, ~~are the most important characters for the paleontologist.~~

2. Proportions. The breadth as compared to the length of a bone is often diagnostic. Or again the height of a condyle or process may be expressed relative to some other measurement of the bone. ~~Proportions~~

~~are safer characters to use in fossils than actual size.~~

3. Actual size. ~~Sometimes modern~~ Occasionally species may be separated purely on this basis, one being decidedly larger or smaller than all others of a genus, ~~This is not a safe single criterion, however, in dealing with fossils, but should be combined with other characters.~~ but the character is less reliable than either of the others.

An item which must be taken into consideration in studying fossil bones, is that similar adaptations must not be mistaken for actual relationship. This is particularly important with the older fossils. Such a bird as Hesperornis, for example, from the Cretaceous of Kansas, has leg bones, modified for aquatic life, which are strikingly similar to the leg bones of the recent Loons. Detailed study of the elements, however, reveals basic distinctions, and a knowledge of the complete skeleton of Hesperornis shows the bird to have been of a very primitive type, with toothed jaws, and far removed from the living loons, though occupying a simlar environmental niche at the time of its life on earth.

The Origin of Birds and the Early Avian Record

It is evident that birds arose from reptilian stock, possibly from the same stock which gave rise to some of the small dinosaurs. There is some difference of opinion, however, as to the nature of the immediate ancestor. Discussion has centered around the question as to whether the "proavis" was an arboreal form which initiated its attempts at flight by gliding downward from one branch to another, or whether it was a terrestrial, running and leaping form which gradually increased the length of its leaps by the use of the extended forelimbs. Like most subjects in which good arguments are advanced on both sides, the truth is probably to be found in a middle course -- in this instance the derivation of birds through an ancestry which involved both types of living habits in the course of development. With a picture in mind of certain of the small living lizards which rise to the hind legs in a rapid dash across open country, yet cling with the four feet to rocks or the branghes of a bush, it requires little stretch of the imagination to visualize a still more active creature, fleet of foot on the ground, leaping to the low branches of a bush or tree, running up the tree, and jumping (~~xxxxxxxxx~~) from limb to limb in pursuit of prey.

The earliest fossil record of birds comes from the Jurassic lithographic slates of Bavaria. Here two specimens were recovered, which, due to an unusually fortunate circumstance of preservation, show not only practically the complete skeleton, but also the delicate, though distinct impression of the feathers. Without this latter, unmistakably avian characteristic, it would have been difficult immediately to recognize the remains as bird, for many of the skeletal characters are strongly reptilian. For this reason the specimens have been assigned to a separate order of birds, the Archaeopterygiformes, the individual birds being known as Archaeopteryx and Archaeornis.

In these primitive birds the upper and lower jaws each bear a row of sharp-pointed teeth, not unlike those of a lizard. Other features of the skull, also, are reptilian, resembling some of the small Mesozoic dinosaurs. Figures and show the skull of Archaeopteryx compared with that of a small dinosaur and one of a typical modern bird. Note that the bones called the frontals are restricted to the fore part of the skull in the primitive bird and the dinosaur, and the cranial region is small. The nasal openings are very far forward, with a space (preorbital fenestra) between them and the eye socket (orbit). The jugal bone appears heavy in comparison with the slender rod of the true birds.

The digits of the fore limbs in the Jurassic bird all terminated in distinct claws, which character favors the arboreal theory of ancestor of birds. The hand and wrist bones are not united as they are in modern birds, though the number of hand bones shows the reduction to three. This condition is strikingly similar to that found in Ornitholestes, a small running dinosaur of the same period.

The hind limb, too, lacks the specialization of modern birds. The bones of the foot, though reduced in number and lengthened considerably, remain separate, again resembling some of the bipedal small dinosaurs. The reduction in number and lenthening of the metatarsals points to a previous running ancestor.

A markedly reptilian feature of the skeleton of the Jurassic bird is the long, bony tail which in this case, however, formed the central flexible rod for the attachment of symmetrically arranged feathers. In modern birds, of course , the tail vertebrae are reduced and the terminal ones are fused into a single bone, called the pygostyle, to which the feathers of the tail attach fan-wise.

Primitive characters of Archaeopteryx are evident also in the pelvic and shoulder girdles. The pelvic bones are unconnected

posteriorly, a character which we have noted for the Paleognathae among recent birds, also. The coracoid is broad and platelike, suggesting the reptilian condition, a character which is maintained, also in the modern Palaeognathae.

Though the feathers of Archaeopteryx were well developed, the general structure of the body lacked the compactness of the typical flying birds and it is probable that the bird was capable of one of the simplest feats of flying.

By the Cretaceous period, the bird skeleton was much more clearly avian, though in the two principle groups which are represented by well preserved fossils, reptilian features were still evident, particularly in the skull.

The Cretaceous of Kansas has yeilded two distinct types of birds the Icthyornithiformes, characterized by the genus Icthyornis, and the Hesperornithiformes, characterized by Hesperornis. In both groups the jaws are toothed and the brain cavity is considerably less developed than in modern birds, while the bones of the pelvis are unconnected. Hesperornis also has the primitive type of flattened coracoid and a completely keelless sternum. As it was a flightless creature, many of its more pronounced characters are associated with this specialization. The fore limb is much reduced -- the wrist and hand elements being entirely absent, the foot bones are well-connected and compressed into a thin tarsometatarsus. Unlike the flightless birds of the struthious type, the bird was not cursorial, but was adapted for aquatic life, the leg bones being somewhat similar to those of the modern loons and grebes.

Icthyornis was a flying bird with well-developed sternal keel and shoulder girdle similar to modern flying birds. The carpometacarpus and tarsometatarsus are well-formed. In fact, except for the toothed jaws, the small brain cavity and the separated pelvic bones, the members of this group are scarcely distinguishable from living birds.

Seventeen species of birds have been described from the Cretaceous of North America, all but one of which are now assigned either to the Hesperornithiformes or to the Ichthyornithiformes. The excepted species (from Canada) was a toothless form assigned to a separate order, the Caenagnathiformes. In spite of the lack of teeth, the jaw of this creature was extremely primitive, having certain characters in common with the dinosaurs.

One Cretaceous species is known from South America and six are represented by fragmentary skeletal remains from Europe. Though authorities differ as to the classification of these birds (no skulls being discovered), two of the European forms show close resemblance to the North American Hesperornithiformes, and it is not unlikely that the South American form is also of this group. The other four European birds have been assigned to existing Carinate families for want of definite proof to the contrary, though it is strongly suspected that all Cretaceous birds were of basically more primitive type and likely not even members of existing orders. It is impossible to ascertain this fact definitely, however, when the skeletal parts which reveal the primitive characters (skull and pelvis in particular) are not represented. Through parallel adaptations to similar modes of life, the limb bones, most often found, are apt to bear superficial resemblances to those of modern types, while the more basic structure is still primitive. A similar example of convergence is well known in the mammals where the Australian marsupials have assumed many adaptive characters similar to the true placental mammals of the rest of the world.

List of birds of Cretaceous: Gallornis -- anserine, femur; Enaliornis (2 species) -- loon or grebe-like, leg bones; Scaniornis (coracoid) and Parascaniornis (vertebra -- flamingoes; Elopteryx (legbone) -- pelicaniformes; Cimolopteryx (2 species) (scapula and coracoid -- Ichthyornithid; Neogaeornis (tarsus) -- Hespernithid; Hesperornis 3 sps. Ichthyornis ((7 species);Coniornis (hesperornithid), Hargeria and Baptornis (hesperonrithid); Apatornis (Icthornithid); Caenagnathus (mandible)

Birds of the Tertiary

The Tertiary period saw the extinction of the toothed birds and the advent of nearly all of the modern avian orders. The Eocene epoch seems to have been the transitional period in the development of bird life, witnessing the last of the primitive birds and first of the modern.

Three species of presumably toothed birds are known from fragmentary material found in the Eocene of Europe. The jaws of these birds bear socket-like holes which have been interpreted to be the alveoli of teeth. Two others have been recorded in which true teeth are absent but bony processes of the jaw have assumed the role of teeth. The presence of these birds with pseudo teeth, as well as the many forms, which, like modern birds, were completely toothless, indicates that the three Eocene toothed birds were merely remnants of the more primitive type which characterized the Jurassic and Cretaceous periods.

The majority of the known Eocene birds were of the toothless type, of true birds. Recognizable ancestral forms of at least eighteen of the existing orders were represented. Many of these birds were of a more generalized sort than those known today, having characters in common with more than one of the modern orders and affording a basis for more clearly understanding the relationships and evolution of recent forms. For example, the bird, Colymboides, had characters similar to both loons and grebes, Romainvillea linked the ducks and geese, and the petrel-albatross and pelican-cormorant groups were represented by several linking forms, as were also the rails and gallinules and various families of shorebirds.

Other Eocene birds were readily assignable to one of the present family divisions, though distinct from modern genera. Such, for example, were Paleorallus, a rail, Fulicaletornis, a coot, Agnopterus, a Flamingo and Protogrus, an early crane.

In addition to the representatives of modern orders and families

were the birds of the order Diatrymaiformes, a group known only from Eocene deposits and having no close living relatives. ~~The members of this order were of giant size~~. The type genus, Diatryma, is best represented in Eocene deposits in Wyoming where practically a complete skeleton was recovered. The genus is known also, however, from deposits in New Mexico and New Jersey, while related genera have been recorded from deposits of ~~xxx~~ Eocene age in Europe. Diatryma is perhaps the most spectacular fossil bird recorded from North America. It is also important as being one of the few Eocene birds to be known in detail. Standing some seven feet in height, it approached the large struthious birds in size. Its huge head, with heavy, high, parrot-like beak gave it a superficial resemblance to the South American Miocene bird, known as Phororhacos. Close study, however, shows Diatryma to have been distinct from either the struthious forms or Phororhacos, with no definite affinity for any other now known form, ~~xxxx~~ The only possible living relative is the Cariama of South America, a much disputed species now allocated to the order of the cranes. To express properly the relationships of Diatryma it was necessary to erect a new order which has been placed between the cranes and the shorebirds.

the large struthious birds in size. Its huge head, with heavy, high parrot-like beak gave it a superficail resemblance to the South American Miocene bird, Phororhacos. Close study, however, showed Diatryma to be distinct from the sturthious forms and from Phororhacos, with no definite affinity for any other then known form, with the possible exception of the living Cariama of South America, a much disputed species, now allocated to the order of the cranes. To express properly the relationships of Diatryma it was necessary to erect a new order which has been placed between the cranes and the shorebirds. The Diatrymiformes were apparently an aberrant group of short duration. There is no record of any birds before or after the Eocene which are assignable to the group.

The modern avian orders represented in the Eocene included the grebes, the pelicans, the ibises, the ducks, the diurnal raptores, the gallinaceous birds, the cranes and rails, the shorebirds, the pigeons, the cuckoos, the owls, the swifts, the trogons, the kingfishers, the woodpeckers and the perching birds. Of these the pelicans, the raptores, the gallinaceous birds, the crane-rail group and the shorebirds have had a full record throughout the Tertiary of North America. With the raptores, however, the Eocene representatives are found only in Europe, the three North American species originally assigned to this order having been recently reallocated. The group is well represented in America after the Eocene, however.

The first of the Sphenisciformes, Procellariiformes and Psittaciformes appeared in the Oligocene, and the number of modern families represented increased to thirty-eight, while several more modern genera were added. By the Miocene, less than half the fossil birds recovered differed sufficiently from those of the present day to justify generic distinction. A large portion of the distinct genera are found in the penguins, which though already adapted for the peculiar combination of terrestrial and aquatic life which they lead today, were still undergoing some slight change of wing proportions, and of tarsometatarsal shape.

Another group in which ~~marked~~ basic characteristics ~~are~~ very already present which characterize the living boobies in ~~the Miocene~~ at an early period is that of the Boobies. The closed external nostrils are observable in specimens from the Miocene diatomaceous shale at Lompoc, California.

A particularly interesting occurrence in the Miocene of Nebraska is the tarsometatarsus of a vulture, Palaeoborus, whose living relatives are entirely confined to the Old World. The fossil history of these ~~aegypiine~~ vultures is one of the rare distributional records which avian paleontology has been able to contribute. This genus, Paleoborus, is found again in Pliocene beds of New Mexico, while in deposits of the same age in South Dakota is found the related genus Neophrontops which carries over into the Pleistocene and is abundantly represented in the asphalt deposits of that age in California. With Neophrontops in the Pleistocene is another genus, Neogyps, which shows genetic relationship to the Old World Vultures, but has adaptive characters which indicate more rapacious habits. We see, then, that the name "Old World" Vultures is a misnomer, for only in the Recent are the members of this group confined to the old world.

Before the close of the Tertiary, in the Pliocene epoch, all but five of the families of birds which are known from fossils at all, were represented. There are many families, of course, which are not recorded as fossils. This does not necessarily mean that members of these groups were not living in the past. We have already seen the part that chance plays in the preservation and discovery of fossil remains, and it is therefore to be expected that some of the rarer families, particularly those which include only upland species, should fail to be recorded. Nearly all of the genera of Pliocene birds are the same as those of the modern, and even a few Recent species are represented. By the close of the Tertiary period, then, the bird life of the world had reached a point where basically it differed but little from that of today.

The perching birds put in their appearance at this time, with three extinct species of shrikes and another form between the titmouse and the old world warblers in character. The raptores were represented by an American Vulture and an ealge-like form. The pheasants first occurred; the cranes were well established and were distinct from the rail-gallinde group which appeared at this time. The herons, flamingoes and ibises were separated. Among the sea birds, the divers were not yet distinguished into grebes and loons, nor were the cormorants and boobies distinct. A large bird, Gigantornis, showed characters linking the Shearwater-Albatross group (Procellariformes) with the pelican-cormorant group (Pelecaniformes) and probably was the last of an ancestral stock whcih gave rise to both of these lines. The Procellariiformes were not distinguishable as a separate order until a few million years later (Oligocene epoch) when the first Shearwaters appeared.

By the middle of the Cenozoic Era, ~~in the~~ (Miocene epoch), about 30,000,000 years ago, most of the main groups of birds we know today were recognizable. From that time up to the present day, the changes which have taken place have been relatively small

Cassowary after Trimen Caprimulg Owl

The branches of Darwin tree were multitudinous and most

~~With the exception of certain a few lesser known [illegible] who [illegible] have been Dodo Penguin do not appear in the previously~~

New genera and species have appeared & the older ones have died out but the major evolutionary steps ~~in the development~~ the class as a whole had apparently all been accomplished by Miocene times.

crawling forms

belly ground

Camptognathus

preavian

archaeopteryx

grebe - loon

Hesperornis

duck - swan

flamingo - heron

cormorant - booby - pelican

Odontopteris ?

shrikes

titmouse - warbler

pheasant

curassow - rail (gallinule)

cranes

rails

herons

flamingo

Ibis

vulture

hawks

Shamaden (Olyo)

	Colymbiformes	Gaviiformes
Pleistocene	Modern and extinct species. Genera modern	Modern species
Pliocene	Extinct species; possibly 1 modern. Genera modern Europe and America	Extinct species Europe and America
Miocene	No record	No record
Oligocene	First true grebe -- extinct species, modern genus. N. America	First true loon -- extinct species, modern genus. N. America
	Also *Colymboides minutus with both grebe and loon-like characters. Europe	
Eocene	*Colymboides anglicus with characters similar to both grebes and loons Europe	

Approximately 60,000,000 years ago

Cretaceous Upper	*Hesperornithiformes Possible offshoot of common grebe-loon ancestral stem. America
Lower	*Enaliornis (two species) Possibly ancestral to grebes and loons, and to Hesperornithiformes. Europe
Jurassic	None
Triassic	None

Approximately 180,000,000 years ago

	Procellariiformes	Pelecaniformes
Pleistocene	Modern albatross, fulmar, shearwaters. Extinct petrels in So.America and Bermuda.	
Pliocene	*Diomedea anglica, England. 2 extinct shearwaters, America.	Extinct species, modern genera: Pelicans, Amer., Asia Cormorants, Amer., Europe, India Anhinga, Europe Extinct genus and species; Sulid with cormorant-like adaptations
Miocene	Extinct species, but modern genera (1 exception) Albatross, Shearwaters, Fulmar -- America Shearwaters -- Europe *Diomedea anglica. Amer.	Extinct species, modern genera: Pelicans -- Europe Cormorants -- Amer., Europe Sulids -- Europe, Amer. Also extinct genus of sulid Extinct form between pelican and sulid. Extinct family combining cormorants, sulids, anhingas with pelicans.
Oligocene	Extinct species of Shearwater (modern genus) *Hydrornis natator, possibly between Procellariiformes and Anseriformes. Europe	Modern families, genera, extinct species: Pelicans, Europe Sulids, Europe Cormorants, Europe, Amer.
Eocene	*Gigantornis eaglesomei. Offshoot from possible common stem of Procellariiformes and Pelecaniformes. Africa.	*Elopteryx[idae continue] ~~Eostega of extinct family~~ ~~Close relationship of cormorants and sulids~~. *Prophaeton shrubsolei, possibly of Phaetontidae but near common stem of sulids and cormorants Extinct genus pelican [Prodo- pelecanus] *Argillornis, possibly of Sulidae All European.

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*Elopteryg[idae] ~~of extinct family~~ possibly [related] to sulids and cormorants.

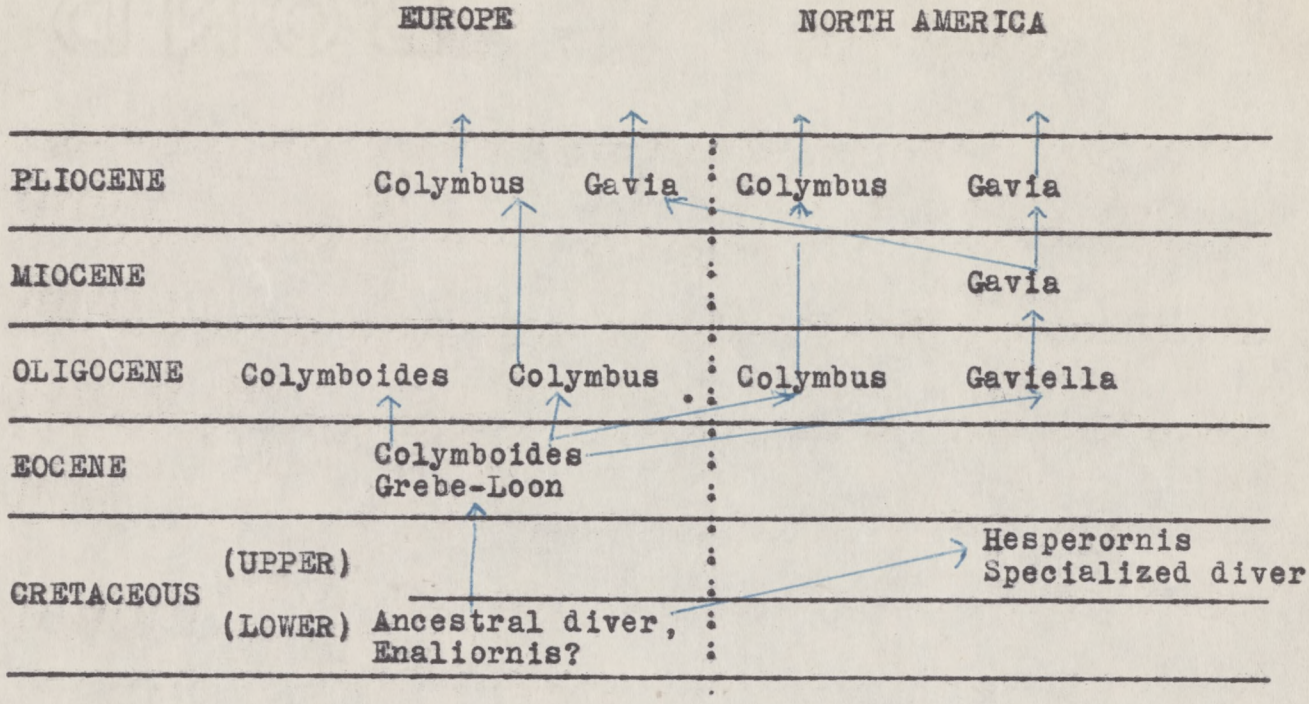
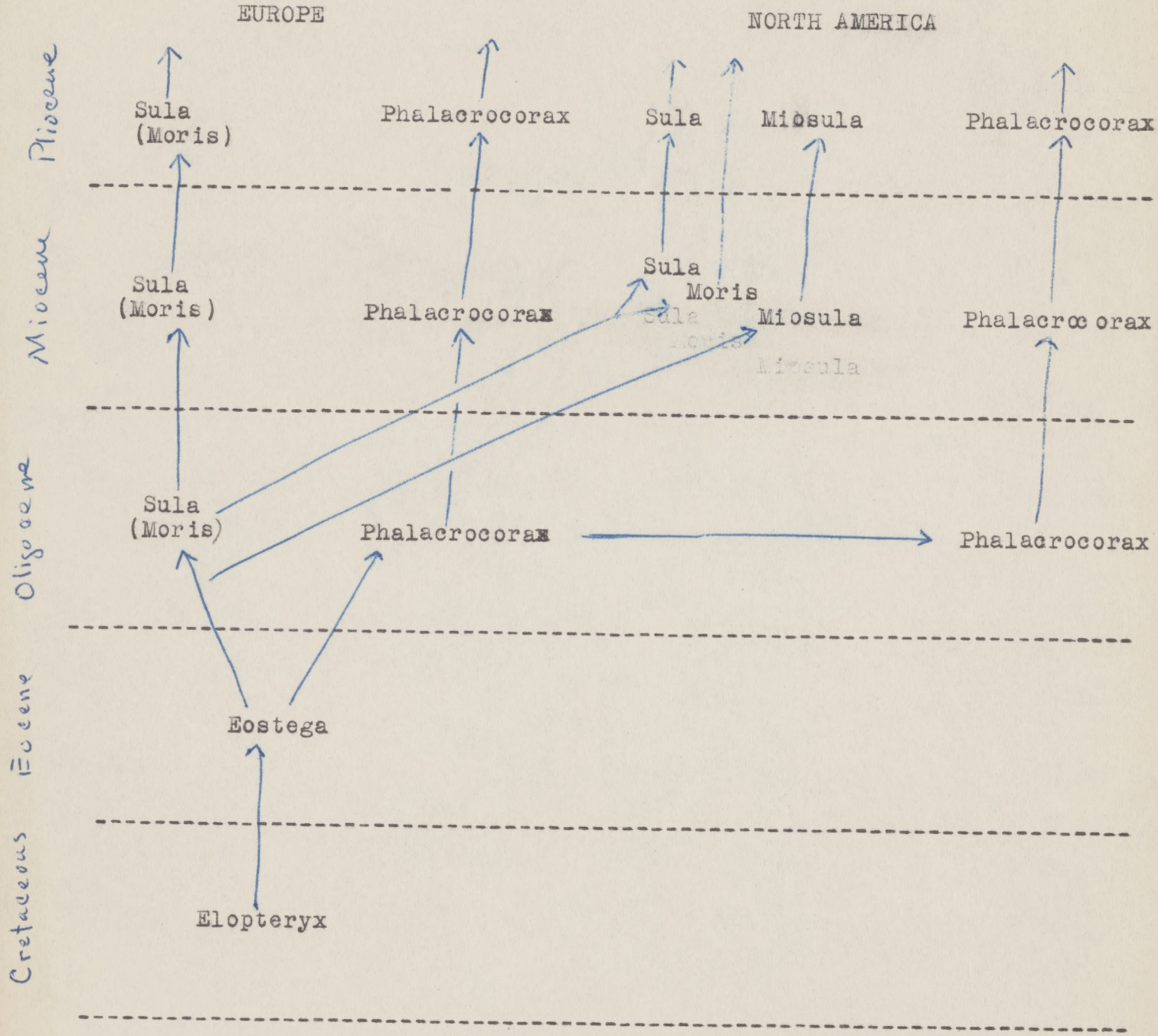
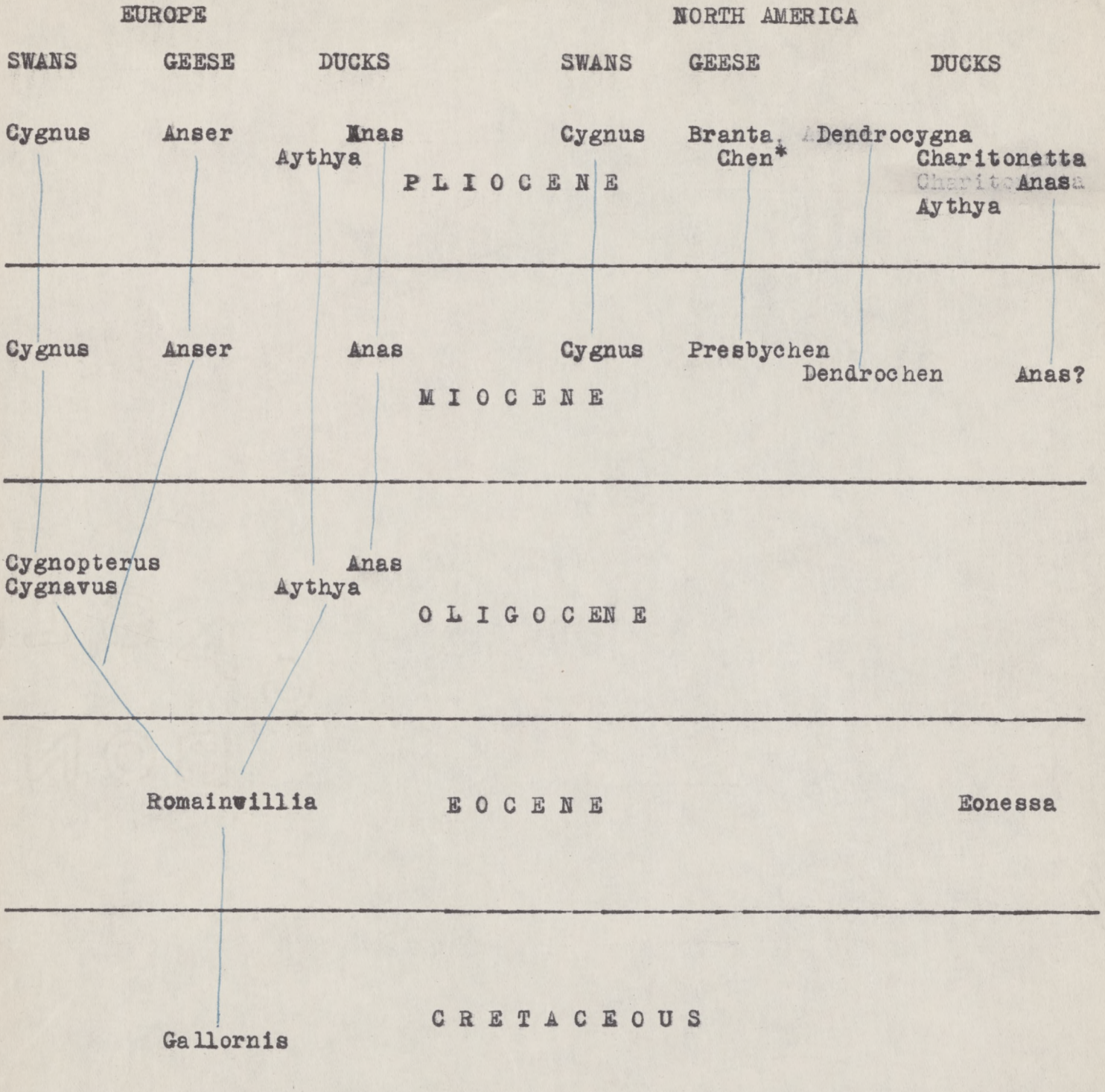


Fig. 2. Chart showing possible relationship of recorded Mesozoic and Tertiary fossils of diving birds of the grebe-loon type.

p. width 5" 4½"


EUROPE
NORTH AMERICA
Pliocene
Miocene
Oligocene
Eocene
Cretaceous
Sula (Moris)
Phalacrocorax
Sula
Miosula
Phalacrocorax
Sula (Moris)
Phalacrocorax
Sula
Moris
Miosula
Phalacrocorax
Sula (Moris)
Phalacrocorax
Phalacrocorax
Eostega
Elopteryx



* Chen = Anser according to Delacour and Mayr (1945, p. 9)

Fig. . Chart illustrating occurrence of fossil anatids in Europe and America during the late Mesozoic and Tertiary.
Lines indicate possible lines of descent within an area.

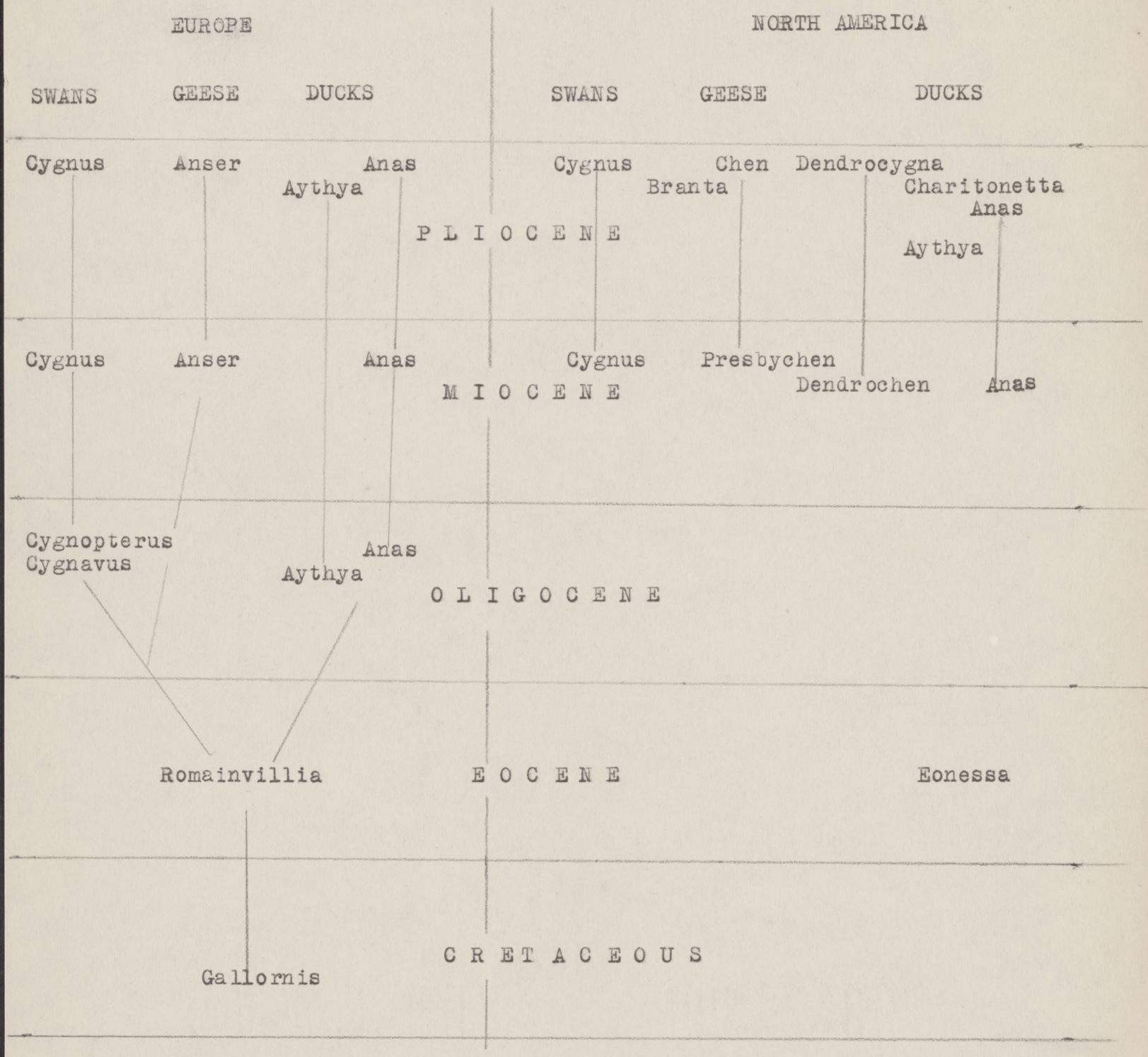
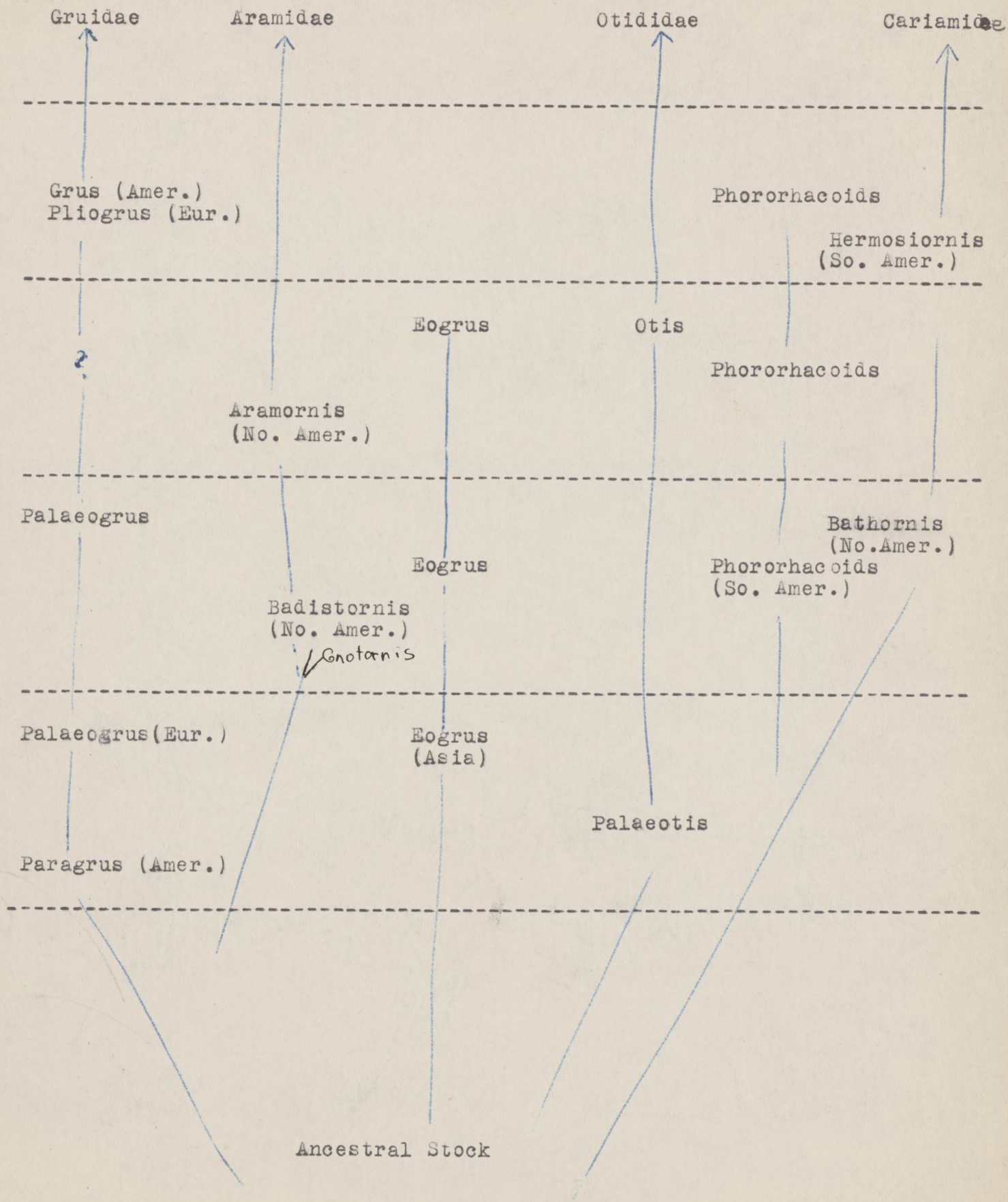


Fig. 5 Chart illustrating occurrence of fossil anatids in Europe and America during the late Mesozoie and Tertiary. Lines indicate possible lines of diescent within an area.

	Falconiformes	Galliformes
Pleistocene		
Pliocene	Modern genera, extinct sps.: Cathartidae - N. and S. Amer. Accipitridae Buteoninae - Amer. Falconidae - Eur. Extinct genera and sps. Accipitridae Milvinae - Amer. Aegypiinae - Amer., Asia Falconidae? - So. Amer.	Modern and extinct gen., extinct species: Cracidae - Amer. Phasianidae - Eur., As. A Meleagrididae - Amer.
Miocene	Extinct genera and species (some modern genera among the Buteoninae): Accipitridae Buteoninae - Eur., Amer. Milvinae - Amer. Aegypiinae - Amer. Falconidae - N. and A. Am.	Modern and extinct gen., extinct sps.: Cracidae - Amer. Tetraonidae - Amer. Phasianidae - Eur., N. and S. Amer.
Oligocene	Extinct genera and species (except genus Buteo) Cathartidae - Amer. Sagittariidae - Europe Accipitridae Milvinae - Eur. Buteoninae - Eur., Amer. Aegypiinae? - Europe Extinct subfamily of Accipitridae between kites and hawks (Palaeoplancinae)	Extinct genera and sps. (except 1 Meleagris) Phasianidae - Eur., Amer. (inclusive (True pheasant - Amer. Amer. type quail - Eur.) Meleagrididae - Amer.
Eocene	Extinct genera and species Cathartidae - Eur. Sagittariidae - Eur. Accipitridae Buteoninae - Eur. Circinae? - Eng.?) - Eur. Hawk - Mongolia Vulture - Eur. Extinct family of vultures (Eocathartidae) - Amer.	Extinct genera and sps. Tetraonidae or Phasianidae Amer. Phasianidae - Eur. Opisthocomi? - Eur. Extinct family between megapodes and cracids (Gallinuloididae) - Amer.

	Gruiformes	Charadriiformes
Pleistocene		
Pliocene	Modern, and extinct gen., extinct sp. Gruidae - Eur., Asia, Amer. Rallidae- Eur. Amer. Extinct families of Cariamae So. Amer.	Modern genera, extinct sps. Scolopacidae - Eur., Amer. Laridae - Europe Alcidae - Eur., Amer. (also extinct gen and sp. of alcid in Amer.)
Miocene	Modern and extinct gen., extinct sps. Aramidae - Amer. Rallidae - Eur. Otididae - Eur. Extinct family of Grues and Mongolia Extinct family of Cariamae So. Amer.	Modern and Extinct genr, extinct sps. Charadriidae - Amer. Scolopacidae - Eur., Amer. Laridae - Eur.? Amer. (includes Gaviota suggesting link with Scolopacidae, Amer.) Alcidae - Amer. Haematopodidae - Amer. Extinct family near Jacanas but in Charadroidea
Oligocene	Extinct genera and species Gruidae Balaericinae - Eur. Aramidae - Amer., Eur.? Rallidae - Eur., Amer. Otididae - Europe Extinct families Grues - Mongolia (Eogruidae) Grues?- Eur. (Orthocnemidae) Cariamae - N. Amer., So. Amer.	Extinct genera and species (a few modern genera) Scolopacidae - Eur. Laridae?(probably Scolo.* Eur., Amer. Charadriidae - Eur., Amer.
Eocene	Extinct genera and species Gruidae - Eur., Eng., Amer. Extinct families Ancestral to cranes, cariamas and otids, Mongolia (Eogruidae) Crane-like (Geranoididae) Amer.	Extinct genera and species: Scolopacidae?-- Amer., Eur. (some appear rallid, others larid) Alcidae - Amer. Extinct families Ancestral to avocets and stilts (Presbyornithidae) -Am. Rostratulidae? -- Eur. Related to rails and shorebirds

Some gruiform relationships suggested by the fossil record



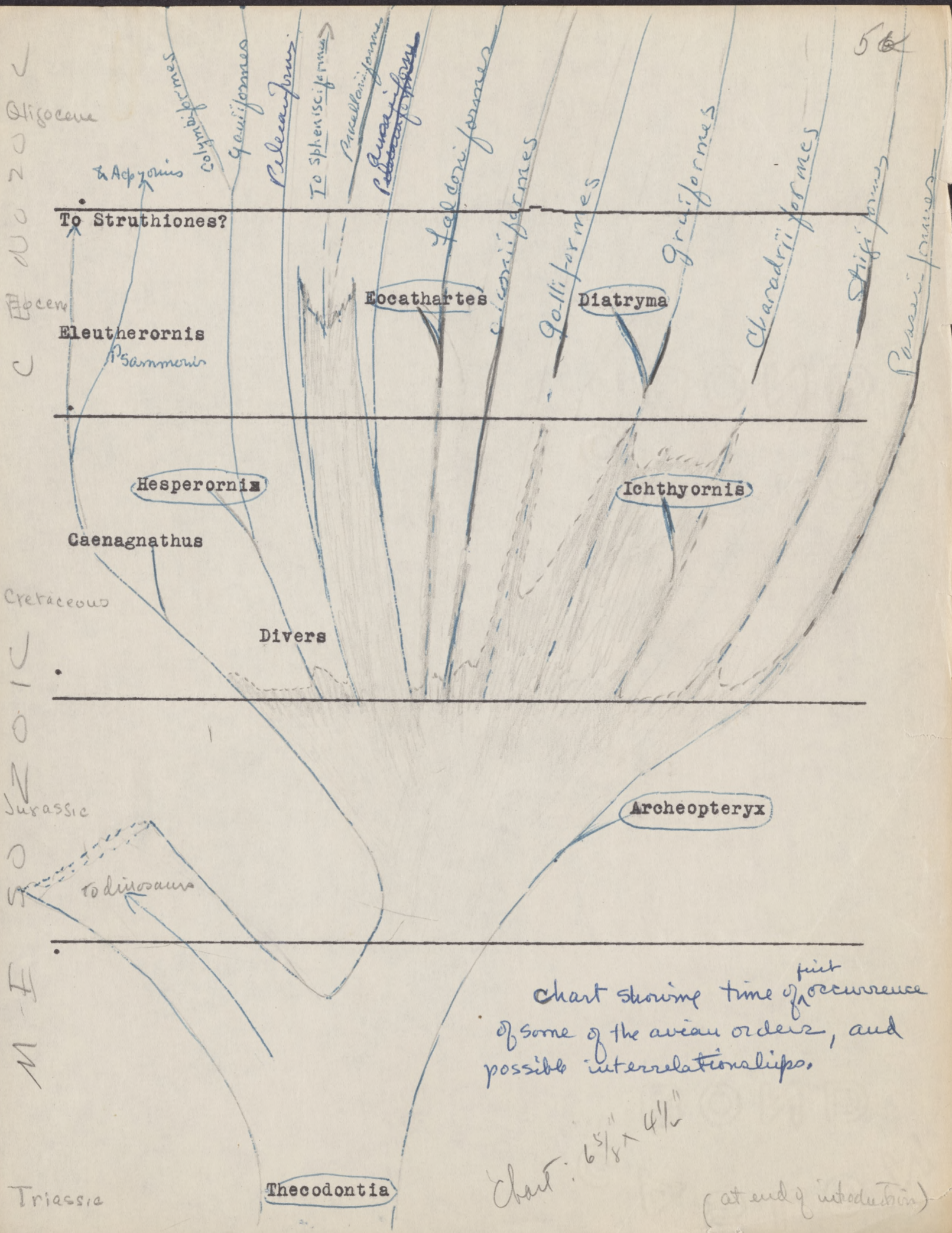


Chart showing time of first occurrence of some of the avian orders, and possible interrelationships.

Chart: 6 5/8" × 4 1/2"

(at end of introduction)

Europe — Grebes & loons — America

No fossil grebes and loons are known from Europe at this age though it is certain they were present

Four other grebes and two loons are also represented three of which are extinct, the other three still existing today

The genus Colymbus is now represented by one extinct species and 3 which are still existing

Pleistocene

The loons ~~are~~ gavia now represented by three extinct species ~~Gavia~~ portisi

The first true loon is recorded Gavia, species?

The genus Colymbus again occurs

Pliocene

No remains of grebes or loons are known from Miocene deposits

Miocene

Colymboides again appears with the species minutus and a true grebe also occurs

A living genus of grebes, Colymbus appears represented by a species now extinct

Oligocene

Colymboides anglicus a bird having characters similar to both the grebes and the loons is the first record of the group

Eocene

Cormorants, Boobies, Pelicans, anhingas

Europe | America

Pleistocene

Pliocene

Miocene

Phalacrocorax
in Calif. & Oregon.

Oligocene

Actiornis anglicus
extinct genus & sp.
Similar to Phalacrocorax
Argillornis longipennis
Layt bird related to albatross & Sula

Eostega lebedinskyi
resembling cormorants
and boobies

From West Sumatra
Protoplotus Beaufortii an
extinct Anhinga

Graculavus 2 spp. of
cormorant in
New Jersey

Eocene

Ondontopteryx toliapica †
Pseudodontornis longirostris had no true teeth but
the jaw bone was serrated instead of teeth. Relations

between this group, Tubinares
† Telmatornes & Phalacrocoracoideus

Eocene | Oligocene | Eocene | Oligo | Eocene | Oligo

America

Eocene
Eocenites
[Thermos?, tiny fragment W. Yonds. B. Hamonds Prof. Harris not found Eocene?)

Oligocene
N. Staples
N. Dakota
Pleisto
NO Dakota
Mio. - S. Ann.
No Hampshire
til (Lake Lapes)
Dew. Mad.

Up. Oligo
of Patagonia
horizons
in Antarctica
Other Antarctic
fauna like
of Patagonia
Oligocene
Eocene
Mex. Calif.

Pleistocene
Chamizzos?
Palaeolynx
(cat like)

Europe

Protheodens
England
Ibidopsis
(Abid)
Archaeus
Hamps?
Eleonis
Hamps

Proardea
like a little
egret (France)
Propelargus
(stork)
also found
in [illegible]
Paris
Palaeodes
Stork
Eleonis?
Palaeolynx
Hamps

Eocene
Oligo
Mex. Calif.
Antarctic
fauna like
Patagonia

Up. Oligo
Auvergne
France

Hawks?
Vultures

	Colymbi & Gaviiformes		Procellariiformes		Pelecaniformes	
	Eocene	Oligocene	Eocene	Oligocene	Eocene	Oligocene
America E	None but Hesperornis in Cretaceous	Colymbidae Gaviella		None in America before Miocene	~~Graculavidae~~	Oligoraptor ~~Phoenicopteridae~~ Anhingidae ~~Pseudodontornis~~ from ~~Pearce~~ belongs to this order which is doubtful
Europe	Colymbiformes	Colymbidae	Gigantornis in Sud-Nijer bet. Tubinares & Steganopodes twice as large as Albatros	Hydrornis birds between Anseres & Tubinares (France) Closest to Puffinus up. Oligo. Puffinus also in Up. Olig of France	Protopelecanus (Russia) argillornis (Sudan ? Burma) Elopteryx (Sula-Pelecanus? Cretaceous) anhingas (common Eoc.) Eocarga Booby-pterodont	Sula France & Austria (?)

Eurem		c		Colymboides			
Oligo		Colymbus Garzilla		colymboides			
Mixeus							
Pleuroc		Garcia		Garcia			

← {Procellariformes / Procellariidae | Pelecaniformes / Pelecanidae

	Cat	Eo	Olig	Mio	Plio	Plei	Sub Rec	Rec		Cat	Eo	Olig	Mio	Plio	Pleis	Sub fos.	Rec
France			M	M²					France			M					
									Germany				M²				
New Zeal						M											
Lord Howe I.						M			Fiwable India						M²		
Sardinia						M			Pitesmi Odessa						M		
									Australia							M²	
Bermuda							M										
Calif.				M²													
Maylan				M													
									Brit Col.				X				
									So. Car.				X				

Ostrich

Archaeornithids

	Eo	Olig.	Mio.	Plio.	Plist.	sub fos.	Rec.
Swaziland				—			
India				✓			
Samoa				—			
(So.) Russia				✓	✓		
Persia				—			
China				✓	✓		
Egypt				—			
Naples					✓		
N. Afr.						✓	
Egypt		—					
Fayum		✓					
Madagascar					✓	✓	

Eocene

Procellariiformes	Pelecaniformes	Ciconiiformes	Anseriformes
		Ardeidae	
Gigantornis eaglesomei	Prophaethontshuvosbai	Botaurides parvus	Gallornis straeleni
—	Protopelecanus sp.	Eocenornis arcetta	Romainvillea stehlini
	—	Prohaeudus owenii	
	Argillornis longipennis	—	
	—	Threskiornithidae	
		Lithopsis hopwellensis	
	Eostega lebedinskyi	—	
	Actiornis anglicus	agnopteridae	
	—	Agnopterus lawleyorum	
		" hantoniensis	
	Protoplotus beaufortii	—	
	—	Phoenicopteridae	
		Elornis anglicus	
	Odontopteryx toliapica		
	Pseudodontornis		

Cretaceous

Ciconiiformes

Scaniornithidae

Scaniornis lundgreni

Parascaniornis stensiöi

Pliogyps

Paraallus
(bet. vast & Gallinula

Paleogyps (up Oligo)

Paleoallus

Paleogyps (mid Eo.)

Paragyps

Paleocryptonyx francolinus

Ortalis amer.

Paleocryptonyx

Palaeoperdix

Palaeoalectoris

Palaeoalectoris Nebraska

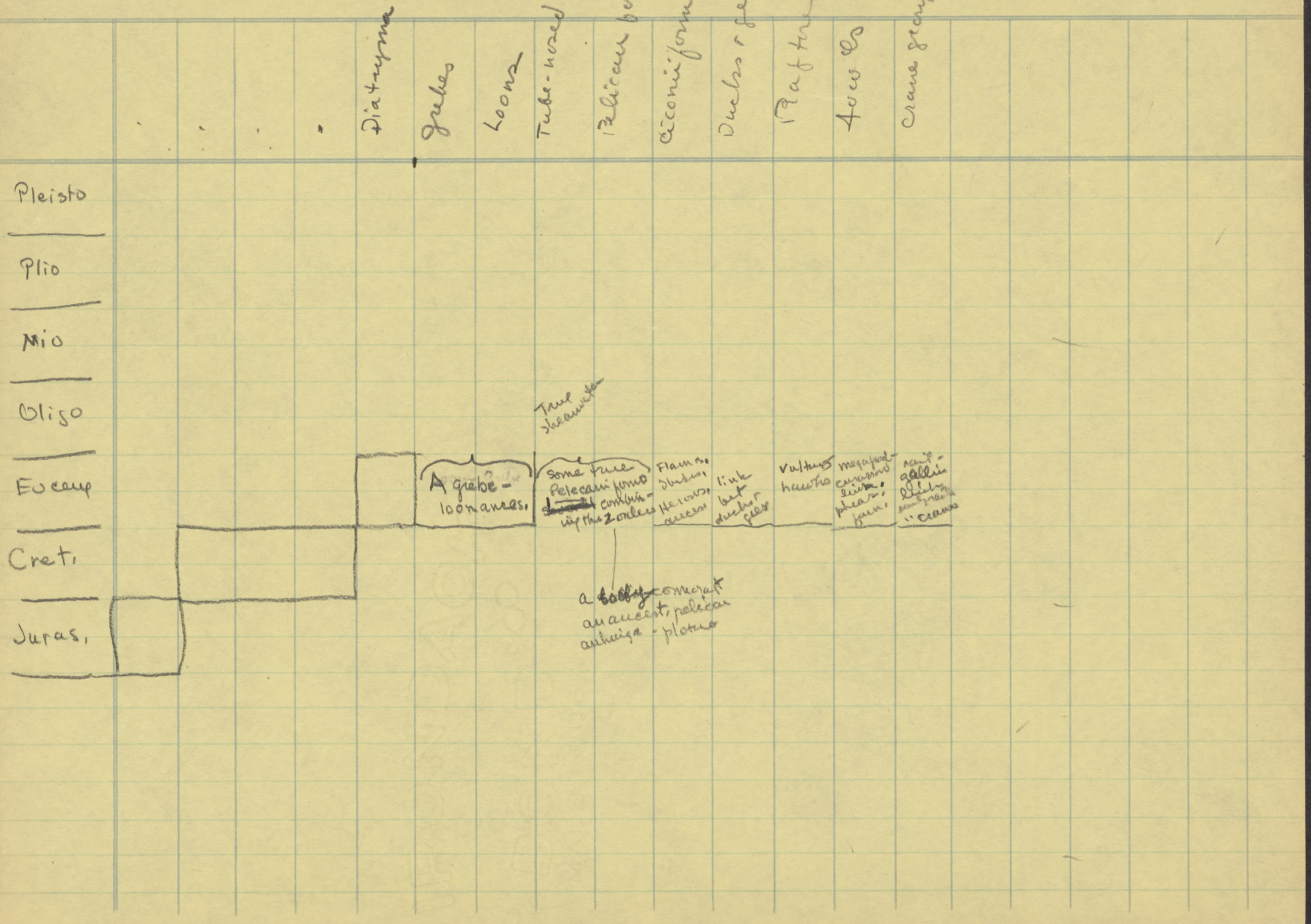
Taoperdix

Paleocryptonyx

Gallinuloides Wyo.

related to cracidae and Eocene

Palaeophasianus


Diatryma
grebes
Loons
Tube-nosed
Pelicans herons
Ciconiiformes
Ducks + geese
Raptors
Auks
crane group
Pleisto
Plio
Mio
Oligo
Eocene
Creti.
Juras.
Aquiloonanes.
Some true Pelecaniformes
Flamingos, Shoebill, Herons, allies
link between ducks + geese
Vultures hamerkop
megapode cracidae limpkin, sunbittern
seriemas, gallinules, finfoots, sungrebes + cranes
Pelecaniformes
ancestral pelecanus + plotus

Europe — Shearwaters, Petrels, Fulmars, Albatrosses — America

One extinct species of shearwater of the genus Puffinus is recorded

The Black-vented, Sooty & Manx Shearwaters, which are still living today, are recorded from the Pliocene as well. Two extinct species of Petrels are represented from very late Pliocene deposits. The only record for a true bird of the Petrels.

Pleistocene.

One extinct species of Albatross

No Pliocene record from America

Pliocene

A bird related to the shearwaters but resembling also the albatrosses occurs here - Plotornis. The fulmar appears in Europe & America. Two extinct species of the genus Procellaria are recorded from Europe

The first American record of the group occurs in this period with five species of shearwater and a fulmar

Miocene

Two species are represented here, one, Hydrornis natator may have been a connecting link between the shearwaters & the ducks. There was a fine shearwater of the genus Puffinus but an extinct species

Oligocene

No fossils of this group from the Eocene, with the exception of one large form called Gigantornis from Africa which appears to have stood between this group & the next in characters.

Eocene

1940's ?

State	Localities	Species	Periods represented
Arizona	1	5	Upper Pliocene
Arkansas	1	1	Pleistocene
California	~~25~~ ~~29~~ 35	~~176~~ 194	Miocene, Pliocene, Pleistocene
Colorado	4	9	Eocene, Oligocene, Miocene
Florida	9	68	Pleistocene
Idaho	3	9	Pliocene, Pleistocene
Illinois	1	1	Late Pleistocene
Kansas	10	15	Cretaceous, Miocene, Pliocene
Maine	1	1	Pleistocene
Maryland	2	7	Miocene, Pleistocene
Mississippi	1	1	Eocene
Montana	3	3	Cretaceous, Miocene
Nebraska	11	21	Oligocene, Miocene, Pliocene Pleistocene
Nevada	4	8	Miocene, Pliocene, Quaternary
New Jersey	6 or 7	15	Eocene, Miocene, Pleistocene
New Mexico	5	61	Eocene, Mio(or Pliocene), Quaternary
North Carolina	1	1	Miocene
Oregon	4	71	Eocene, Oligocene, Pleistocene
Pennsylvania	2	3	Pleistocene
South Carolina	1	1	Miocene
South Dakota	3	4	Oligocene, Pliocene
Tennessee	1	?	Pleistocene
Texas	5	6	Cretaceous, Pliocene, Pleisto.
Wyoming	17	32	Cretaceous, Eocene, Oligo, Pleis.
Utah	1	1	Eocene

Eastgate beds (Mid.)

Eocene – ~~Basal~~ Bas.

Colymbiformes – Eupteronis?

Colymbidae – Colymboides anglicus

Procellariiformes – Gigantornis eaglesomei up.

Pelecani formes

Phaethontidae – Prophaethon (Lon.)

Phalacrocoracidae – Graculavus up.

Pelecanidae – Protopelecanus up.

Anhingidae – Protopelotus up.

Pelagornithidae – Argillornis Lon. & Mid

Odontopterygidae – Odontopteryx Lon.

Ciconii formes

Ardeidae – Proherodius, Botaurodes, Eocoronis ~~Bas.~~ up. N up. A 3

Proardea Eo. Ol.

~~Threskiornithidae~~

Threskiornithidae – Ibidopsis up.

Agnopteridae – Agnopterus up.

Phoeniopteridae – Elornis (? anglicus) up.

Anseriformes

Anatidae – Romanovillea up.

Falconi formes –

Cathartidae – Plesiocathartes (upper most Eo. with Low. Olig.)

? ~~Pandionidae~~ Haliaeetidae Sedis. Tapinopus (elliotti) as above

Sagittariidae – Amplyseyentarius as above

Accipitridae – Palaeotinnus, Milvus (deperditus) up.

Aquilavus → Aquila up. Eo-Olig

Palaeothieras gervaisi up. (Bartonian)

Gallinulo Tilholornis (3) Eo-Olig

Gallinuloididae – Gallinuloides up. A

Palaeocryptonyx " " 1

Phasianidae – Palaeophasianus up. A 1

Gruiformes

Gruidae – Aletornis (3) up. A, Geranopsis up. (2), Palaeogrus mid. (2), 8 7 8

Paragrus, Protogrus, Up. (1) = Aletornis ? A

Rallidae – Paleorallus, Eocrex up. A Telmatornis (3) A Gypsogruis anceps up. 5

Stidae – Palaeotis Mid.

Quercypulles intermedius up. Eo-Ol. (3)

Tulicaletornis occultus up. A

Palaeotyx up. (2) Eo. Ol.

Palaeotyx (2) Eo. Ol.

Lithornis vulturinus Lon.

Cathartes affinis anglicus (Eastonian) = up.

Eocene contd

Pidornis glaronensis up.

Macrornis tantalus up., Eogyps mirus up.

Laornis edwardsianus up.

Diatrymiformes

Diatrymidae – Diatryma (5), Omoramphus 6

Gastornithidae – Gastornis (3), Remornis, Dasornis 5

Charadriiformes

Limosavis velox up.

Rostratulidae – Rhynchaeites mid (Rail?) 1

Scolopacidae – Aenigma up., Palaeotringa up., Totanus up. + Eo., "Philohela" up. 5

Presbyornithidae – Presbyornis up. A 1

Alcidae + Hydrotherikornis up., Nautilornis up. A (2) 3

Columbiformes

Pteroclidae – Pterocles 2 Eo Ol. 1

Cuculiformes

Cuculidae – Dynamopterus (Eo-Olig.) 1

Strigiformes

Ptilostrigidae – Pidostrix up. A (4) 4

Strigidae – Strigogyps (Eo-Olig.)

Necrobyas (2) .. ..

Bubo → .. ..

Asio 5

Micropodiiformes

Micropodidae – Cypselavus (Eo-Olig.) 1

Aegialornithidae – Aegialornis (2) 2

Trogoniformes

Trogonidae – Archaeotrogon (3) 3

Coraciiformes

Coraciidae – Geranopteus 1

Piciformes

Picidae – Cryptornis up., Limnornis up. (Up.-Eo.) 2

Passeriformes

Hebe schuchertia A

Palaeospizidae – Palaeospiza 1

Paridae – Palaeoparus up., Laurillardia up. 3

(3)

Omnitichnites Laurussi Laurussi Laurussi up.

Larus, Pelecanus, Phoenicopterus, Low.

Ol. Elaphrornis phas., grac., cam. Eo-Ol.
Ol. Orthrornis gallicus, major, cam. " "
minor " "
Orthrornidae of Gruiformes

Eocene -

Ciconiides or Palmipeder

Diatryma ? cotei - Gaillard (1936) Parasuchus + phalacr.

sp.? [3 new forms from Geiseltal Rauchrecht (1933) not available.]

[Quidae]

① Eogrus Wetmore 1937 new family Eogrusidae - long legs, wading bird? adeola parasuchus this page.

similar to cranes, [cariamas + otids] "begin the 3 a step nearer to common ancestry"

② Up Eo. Inner Mongolia Gastornides from Wyoming Wetmore 1933 - new family Gastornithidae

Rallidae

Telecrex zangeri - new subfamily Telecrecinae

ancestral to modern Rallidae + could not be separated with the swimming forms" Wetmore 1934

up Eo. Inner Mongolia

Anatidae

Eonessa anatiscula Wetmore 1938 (inc., artic bones of wing)

Utah - new subfamily - earliest ann. Anatid

near Presbyornithinae?

Strigiformes

Protostrix minima Wetmore 1938 closer to Strigidae than Tytonidae

Wyoming

New family Protostrigidae to include minima + another species Bubo leptosteus nb. assigned by Wetmore 1933 + 1937

Falconiformes

① Hawk cracoid from Inner Mongolia. Wetmore 1934

Repres. family group ancest. to Accipitridae

② Discards Falco falconellus Stegeldt (Wetmore 1936)

Wyoming

③ Cracharis gallatoi Wetmore 1944, up Eo. Wyoming still valtura Cracharidae

Ratite

Eleutherornis helveticus Schaub 1940,

Egerkingen Jaw, T and ½ pelvis

Oligocene

all ✓

Outer Mongolia
✓ Equus sp. Hansus / Wetmore

U.S.

Gruiformes
✓ Suborder Cariamae
✓ (1) Bathornis geographicus Wetmore 1942 Hansus, tibia
So. Dakota - Quite descendant of B. veredus from earlier Oligo of Colorado
✓ (2) Bathornis celeripes = B. cursor from Wyo, Wetmore 1933 complete foot
Suborder Grues family Aramidae
✓ (1) Quatornis aramiellus (n. gen + sp) Wetmore 1942
Oligo So. Dakota - dist. humerus
✓ (2) Badistornis aramus Wetmore 1940
~~White River~~ Oligo. So. Dakota.

✓ Gaviiformes
Gavia pusilla = Gaviella pusilla (new genus) Wet. 1940
Wyoming (prob. Oligo.)

✓ Falconiformes
Butorinae & Accipitridae
✓ (1) Buteo grangeri Wetmore + Case 1934 skull
So. Dakota (similar B. borealis)
✓ (2) Buteo antecursor Wetmore 1933 - Hansus
Wyoming. (larger than B. regalis
Phase a ground Buteonine hawks back to Oligo.
✓ Palaeoplancinae & accipitridae
Palaeoplancus sternbergi Wetmore 1933
Oligo Wyo. nearly complete skeleton
Between Buteoninae & Circus.

Miocene contd

Charadriiformes

Laridae - Scolopacidae (?)

✓ Gaviota niobrarae (n. gen., n. sp.) A. Miller 1944 Kan. - Nebraska
more like Laridae but suggestions American
linkage of Laridae + Scolopacidae from Mich
that Laridae may have come after Miocene
Remarks that Laridae of Miocene Eurasia + Africa
& Europe both more Scolopacid,
Up. Mio Nebraska

✓ Alcidae
Miocepphus mcclungi rep'd from Maryland again 1943

✓ Rhegminornithidae (in superfamily Charadriodea near
Rhegminornis calobates Jacanoidea Wetmore 1943 - Florida
coracoid Low. Mio.

✓ Falconiformes
✓ ① Palaeoborus rosatus A. Miller 1939
Possibly closer to Neophron than Palaeoborus
Low. Mio. So. Dakota
✓ ② Palaeoboninae Wetmore 1936 Taxus - Nebraska
✓ ③ Neophrontops vetustus Wetmore Mid. Mio Nebraska
luminis

✓ ④ Palaeastur atavus Wetmore 1943. Mid. Mio. Nebraska
oldest & 1st pouch genera (apparently with Leucopternis
spisaetos + spisastur)

✓ ⑤ Falco ramenta Wetmore 1936
Closest to Pigeon hawks in char. nisi & sparverius
Oldest american Falco

✓ Galliformes
① Ortalis pollicaris - Cracidae carpus A. Miller 1944 - So. Dakota
✓ ② Ortalis fantala Wetmore 1933 tibia - Cracidae (may be new group
Nebraska
✓ ③ Cyptonyx cooki Wetmore 1933 - very large - 1st pouch Cyptonyx - Nebraska
✓ ④ Tympanuchus stirtoni A. Miller 1944 Tetraonidae Taxus So. Dakota
✓ ⑤ Miortyx teres (n. gen. + sp.) Phasianidae Hunt. So. Dakota A. Miller 1944

✓ Columbiformes
✓ Columbid sp. Mio. Maryland Wetmore 1938
✓ Columbid sp related to pouch doves cora - Wetmore 1943 Florida Low Mio
✓ Strigiformes - Strix dakotae Taxus So. Dakota A. Miller 1944 Low. Mio
✓ Phoenicopteridae - Megapaloelodus connectens A. Miller 1944 Low Mio So. Dakota
Gruiformes - near Otis tibia Wetmore 1943 Low. Mio Florida

Miocene

Inner Mongolia
✓ Eogyps sp. 1934 Wetmore – Aegypiidae carried
There 3 ~~records~~ epochs in Mongolia

Australia
Miocene Penguin. – 1st fossil penguin from Australia
Attenborough 1938
Trans-Caucasia – up. Mio. of Baku
✓ Passerine fragments – ~~Tchigkova 1935~~ Rabinin 1934

America
✓ Procellariiformes
① Puffinus diatomicus – new records all Calif.
Lompoc, San Pedro Miller 1935 + Orr, 1940
② Diomedea sp. Miller 1935 – Lomita
~~Rosita~~
③ Diomedea anglica ~~sp~~ ? from Mid Mio. of Fla. (orig'ly from up. Pliocene, England)
✓ Pelecaniformes
✓ ① Sulidae
✓ ✓ Sula stocktoni Miller 1935 – Lomita – imp ostium
✓ Sula anita Wetmore 1938 – Maryland campus
✓ ② Phalacrocoracidae
Phalacrocorax auritis(!!) ? from Mid Miocene Florida Wetmore 1943

✓ Gaviiformes
✓ ① Gavia(?) sp. Tibia – Maryland Wetmore 1941
✓ ② Gavia palaeodytes Wetmore 1943 – cora, smaller than all other known
Florida. Mid. Mio

✓ Anseriformes
✓ ① Paranyroca magna (new family) A. Miller 1939 4 sacrums
Size of swan but ? calc ridges Lower Mio. So. Dakota
✓ ② Dendrochen robusta (Dendrocygninae) Hum. ? Mio. campus
A. Miller 1944 – Lower Mio So. Dakota
✓ ③ Anseranas integra A. Miller 1944 Low. Mio. So. Dakota cora, also
✓ ④ Anser – gen ? sp. ? cora. Mio. Arizona Wetmore 1943
earliest N. Amer. anser

(over) Miocene contd

Pliocene

Quiniformes
Cariamae
✓ Phororacidae –
Andrewsornis abbotti (n. gen. & sp.) Patagonia Patterson 1941
(say = family of Phororacoids)

Anseriformes → Anatidae
✓ Urmiornis abeli Lambrecht 1938 – Persia

✓ Gruidae
Grus conferta – near Mt. Diablo Calif., Tarsus Miller 1942
Grus antecessa – Snake River Idaho
Rallidae
✓ Rallus prenticei Wetmore 1944 – up. Pliocene, Kansas
✓ Gallinula chlorops – (Wetmore 1933) Idaho

✓ Charadriiformes
U Mancalla (Plotornis) diegensis – from San Diego & Mancalla from Corona del Mar
U Brachyramphus pliocenus Howard – San Diego

✓ Pelecaniformes
Pelecanus haliaeus Wetmore (1933) Idaho (Hagerman Lake)
Pelecanus erythrorhynchos ? Oregon Miller 1944 = female
Phalacrocorax auritus (Linn. & cora). Oregon Miller 1944 & Idaho Wetmore
Phalacrocorax kennelli – Howard – San Diego
Miocula recentior Howard – San Diego

✓ Gaviiformes
✓ Gavia concinna Wetmore 1940 – California (2 records Howard)

✓ Ciconiiformes
✓ Phoenicopterus stocki Miller 1944 – Chihuahua Mexico,
✓ Ciconia maltha (Miller 1944) Idaho

✓ Falconiformes
✓ Neophrontops dakotensis Compton 1935 – So. Dakota

✓ Passeriformes
✓ Geothlypis burkei Wetmore 1944 up. Pliocene, Kansas
✓ Geothlypis cayugensis Taylor
✓ Branta duckeyi – Rapid from Oregon (Miller 1944)
✓ Cygnus sp. from Oregon & Idaho Miller 1944)

✓ Columbiformes
Columbus fasciatus – Kern Co. & San Diego records of this Pliocene bird
✓ Phasianidae – Columbus kansasensis Kansas
✓ Meleagridae – Parapavo californicus Wetmore 1944 – Low Pliocene Kansas
Pliocene Texas Miller & Lehner 1937

Gaviiformes

Gavia immer — Olicgo Wyo. Wetmore 1940

Gavia pacifica (mid.) — Miocene Florida " 1943

Gavia (?) sp. Mid. Maryland " 1941

Gavia concinna Plio. Calif. " 1940 + Howard

Colymbiformes

Colymbus parvus Pliocene Calif. " 1937

Colymbus nigricollis " Kansas " 1933

Procellariiformes

✓ Puffinus diatomicus Mid. Calif. Miller 1935, Orr 1940

✓ Puffinus felthami Plio. Newport Howard 1948

✓ Puffinus kanahpi " S.D. " "

✓ Diomedea anglica Mid Florida Wetmore 1943 + up Plio England

✓ Diomedea sp. Mid. Lomita. Miller 1935

Pelecaniformes

Pelecanidae

✓ Pelecanus halieus Plio Idaho Wetmore 1933

✓ P. erythrorhynchus? " Oregon Miller 1944

Sulidae

✓ Sula stocktoni Mid. Lomita Miller 1935

✓ Sula avita " Maryland Wetmore 1938

✓ Miosula recentior Plio San Diego Howard 1948 (genus in Miocene)
Moris reyana Pleito Del Rey? Newport? "

Phalacrocoracidae

✓ Phalacrocorax auritus (?) Mid Mid. Fla. Wetmore 1943

" " Plio. Oregon + Idaho Miller 1944, Wetmore 1933

✓ Phalacrocorax bennetti " Calif. Howard 1948

Ciconiiformes

Phoenicopteridae

Megapaloelodus connectens — Low. Mid. So. Dakota — G. Miller 1944

Phoenicopterus stocki — Plio Mexico — L. Miller 1944

Ciconia maltha — " Idaho — " " 1944

Anseriformes

Anatidae

Genesaninae (near Erismaturinae)

Eonessa anatina — Eocene Utah — Wetmore 1938

① Paranyrocidae – before swans

Paranyroca magna — Low Mid. So. Dakota — Miller 1939

② Cygninae

Swan gen + sp.? — Mid. Arizona — Wetmore 1943

(smallest swan in area.)

Cygnus sp. — Plio Oregon + Idaho — Miller 1944

③ Anserinae

Branta dickeyi — Plio Oregon — " 1944

⑤ Anatinae

Querquedula integra — Low Mid. So. Dakota — G. Miller 1944

Nettion bumbari — Up. Plio. Kansas — Wetmore 1944

Nettion carolinense — Plio. Texas — Compton 1934

④ Dendrocygninae

Dendrochen robusta — Low Mid So. Dakota — G. Miller 1944

Falconiformes

Cathartidae

Coragyps grallator — up Eoc. Wyo. — Wetmore 1944

accipitridae

Hawk sp. gen Mongahain — Eocene - Ang. + accipitrid — " 1938

Aegypiinae

Palaeobonus howardae — Middle Nebraska — " 1936

Palaeobonus rosatus — Low, Mid - So. Dakota — G. Miller 1939

Neophrontops vetustus — Mid Mid. Nebraska — Wetmore 1943

Neophrontops dakotensis — Plio. So. Dakota — Compton 1935

Buteoninae

Buteo grangeri — ~~Oligo~~ S. Dakota — Wetmore 1934

Buteo antecessor — Oligo, Wyoming — " 1933

~~Aq~~ Palaeastur atavus — Mid Mid Nebraska — " 1943

Palaeoplancinae

Palaeoplancus sternbergi — Oligo, Wyoming — " 1933

Falconinae

falco ramenta — Mid. Nebraska — " 1936

Galliformes

Cracidae

Ortalis (?) vantala — Mio. Nebraska — Wetmore 1933

Ortalis pallidiventris — " So. Dakota — Miller 1944

Phasianidae

Centrocercus coatsi (large) — " Nebraska — Wetmore 1933

Miotyx teres — " So. Dakota — Miller 1944

Colinus hibbardi — Plio Kansas — Wetmore 1944

Tetraonidae

Tympanuchus ~~obscurus~~ ? — Mio. So. Dakota — Miller 1944

Meleagrididae

Parapavo californicus — Plio Texas — Wetmore 1937

Anseriformes

Eoanatidae

Eoanas ardeola — Upper Eocene Inner Mongolia — Wetmore 1934

Eoanas sp. — Oligo — outer " — " 1934

Eoanas sp. — Mio. — Inner " — " 1934

Geranoididae

Geranoides jepseni — Eocene Wyoming — Wetmore 1933

Gruidae (Aramidae)

Quotornis aramellus — Oligo So. Dakota — Wetmore 1942

Badistornis araneus — " " — " 1940

Gruidae

Grus conferta — Plio No. Calif — Miller 1942

Grus americana — " Idaho

Grus ~~americana~~ Unionis abeli — " Persia — Lambrecht 1938

Asia Minor

Rallidae

Telecrecidae

Telecrex gaugeri — Up. Eoc. Inner Mongolia — Wetmore 1934

Rallus prenticei — Up. Plio Kansas — " 1944

Gallinula chloropus — Plio Idaho — " 1933

Cariamae

Bathornithidae

Bathornis geographicus — Oligo So. Dakota — " 1942

Bathornis deponens and B. calceopsis — Oligo Colorado — " 1933

B. celeripes + B. curvus — Oligo. Wyoming

Phororhacidae

Andrewsornis abdita — Plio Patagonia — Patterson 1941

Diatryma ~~sp.~~ = Diatrymaëtes — Upper Eo.

Charadrii formes
Laridae & Scolopacidae
Gavia immer — Mid. Nebraska, Mutter 1941
Rhegminornithidae — Charadroidea near Jacanoidea
Rhegminornis calobates — Low Mid. Fla., Wetmore 1943

Alcidae
Mycteppus modestus — Mio. Maryland — Wet. 1943
Manculla calif. + dyeiri — Plio. Calif. — Miller & Howard 1948
Brachyramphus pliocenus — " " — Howard 1948

Columbiformes
Columbid sp. — Mid Maryland — Wetmore 1938
" " (ground dove) — Low " Florida — " 1943

Strigiformes
Protostrigidae (nearer Strigidae than Tytonidae)
Protostrix minima — Eoc. Wyo.
" sanctodonus (Minerva)
" leptosteus (Bubo)

Strigidae
Strix dakotae — Low Mio So. Dakota — Mutter 1944

Passeriformes
Corvothylidae
near Ptilia — Low Miocene Florida — Wetmore 1943
Passerine indet. — Miocene Trans Caucasia — Pidoplichko 1934

Ratitae
Eleutherornis helvetius — Schaub 1940
Eoc. Egerkingen

Passeriformes

Eocene
up. Eocene (Paridae) Palaeothalus (France) only fossil paris
" " Laurillardia (shrike) 3 Europe
~~" " Protorotis~~ (Family ?)

Oligo
up. Oligo Motacilla (wagtail) (2 France)
" " Laniinae Europe

Mio
up. Mio. Paliospiza - Colo.
(separate family
placed betw. lark + swallows)
Mio. Mio. Muscicapa Europe
"Mio" - Palaeostruthus (fringillid) Kansas (close to towhee)
up. Mio fringilla (3-4) Europe

Plio
~~Low~~ Low. Plio alauda (2) Italy
" " ~~sitta~~ (Italy) (only fossil sitted)
up. Plio. Corvus 3 Europe, 1 Amer.
Low Plio. anthus (motacillid family - see Oligo.) Europe
up Plio - Junco Amer.
up " - fringillid Amer.

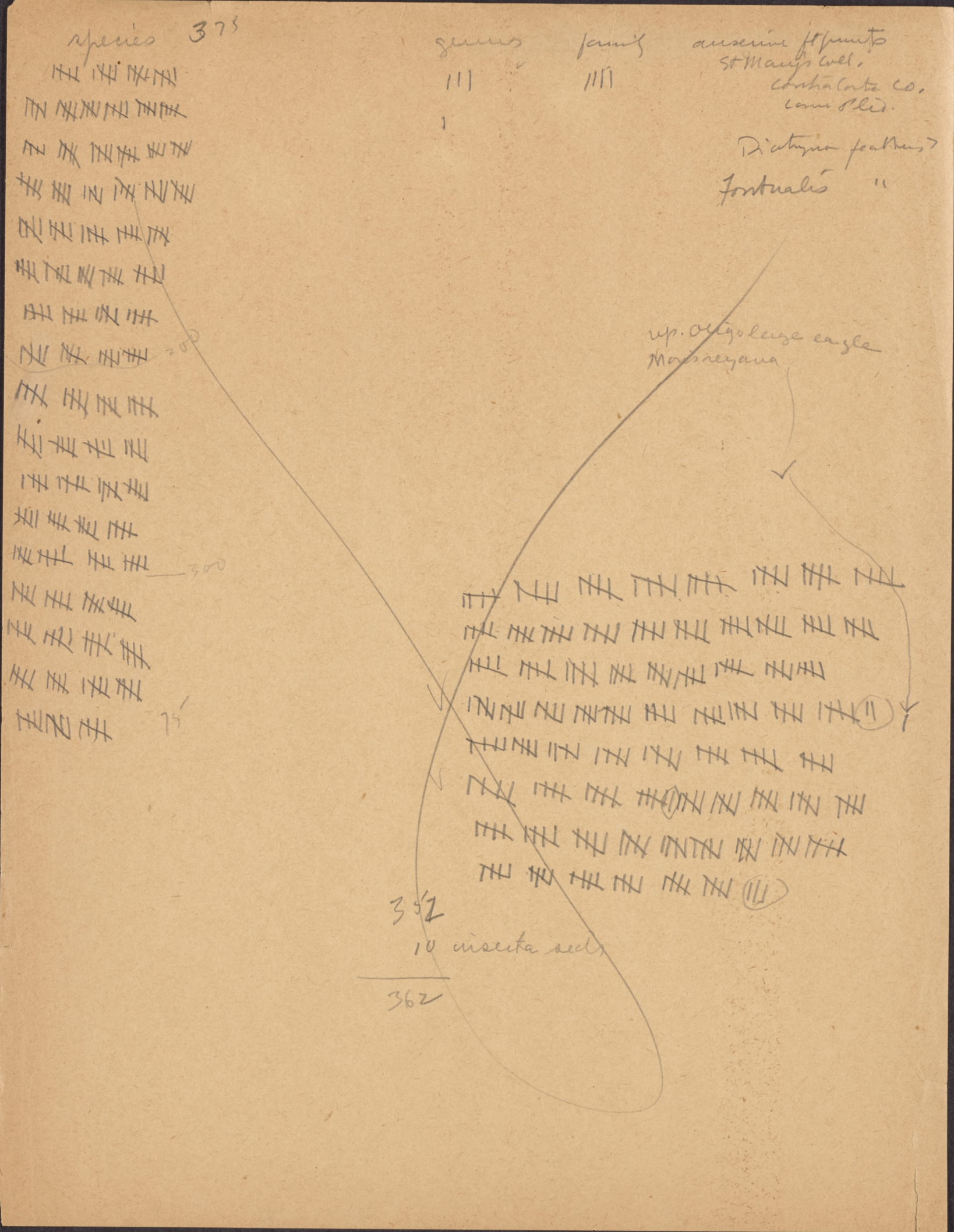
Pleisto
Hirundo - Europe
corvus (1 2 extinct species)
Turdus Europe + Amer.
Finch record of 5 kinds

				sheets
Upper Plio -	Benson	Arizona		5
Pleist		Ariz.		1
Mio.	Bakersfield	Calif.		3
"	Barton	"		1
"	Calabasa	"		1
"	Lompoc	"		6
"	Ricardo	"		1
Plio	Kern River	"		2
"	Santa Barbara	"		1
"	Contra Costa, Co.	"		1
"	L.A. 3rd St	"		1
"	San Diego	"		10 5'
Pleist	La Brea	"		21
"	San Pedro	"		10
"	Del Rey	"		2
"	Mohave (Manix)	"		1
"	La Habra	"		1
"	Workman & Alhambra	"		2
"	Santa Monica	"		67
"	McKittrick	"		5' 3
"	Carpinteria	"		1
"	Rodeo	"		1
"	San José Mesa	"		11
"	Hanover Cave	"		14
"	Potter Creek	"		13
"	Samuel Cave	"		4 ?
"	Santa Rosa I.	"		

Mio.	Edgecombe Co.	N. Car.	1
Trias.	Anson Co	"	? Gnd.
Mio.	Stono Rid.	So. "	1
Eo.	Steamboat Spgs	Colorado	1
Oligo	White River	"	2
Oligo	Weld Co.	"	X
Mio.	Florissant	"	3
Pliocene	St Columbia Co	Fla.	23
"	Seminole	"	51
"	Manatee Co (3 locs.)	"	21
"	Caravan Escambo (Trinidad)	"	10
"	Melbourne	"	17
"	Vero	"	8
"	Castle Creek	Idaho	1
up. Plio	Truman Ferry	"	1
Cret.	Niobrara	Kansas	14 reviewed for no. Gr.
Mio	near Long Pd.	"	1
Plio.	Sherman Co.	"	1
"	Long Pd. Station	"	1
Pliocene	near Bangor	Maine	1
Mio	Calvert Fm.	Maryland	6
Oligo	Cumberland Cave	"	1
Eo.	Jackson	Mississippi	1
Cret.	2 places	Montana	2
Mio.		Montana	1

Eo.	Coos Bay	Oregon	1
Oligo	John Day (above)	"	5
Pleisto	Fossil Lake	"	6 5'
"	Frankstown	Penn	3
	Port Kennedy	"	
Plio		S. Dak	2
Pleisto		Tenn.	?
Cret	Fort Worth Knox	Texas	1
	Randall Co.	"	1
Plio.	~~Hemphill Co.~~	"	1
" Pleist	Canby Co.	"	1
"	Hemphill Co.	"	2
Cret.	Lawrence Co.	Wyo	1
Jurass.	Como Bluff	"	1 ? find ?
Eo.	Henrys fork	"	10
"	Grizzly Buttes	"	3
"	Cottonwood Creek	"	1
"	Sp. John Meadow	"	1
"	Church Buttes	"	1
"	Fort Bridger	"	1
"	Green River	"	1
"	Elk Creek	"	2
"	Cloud's Fork Basin	"	1
"	Bighorn Basin 2 loc	"	3
"	Preuss's Ranch	"	1
"	Worland	"	1
"	Grizzly Buttes	"	1
Pleisto ? age ?	Haystack Mt.		1
Eo	Utah		2

Mio.	Agate Fos. Quary	Nebraska	4
"	Running Water	"	1
"	Long Fork River	"	1
"	Snake Creek beds	"	2
"	Niesp " "	"	3
"	Dawes Co.	"	2
Plio	Snake Creek "	"	3
"	Ogalalla form.	"	1
Pleisto	N. Dana Thenda Riv Co	"	1
"	Sioux Co.	"	1
"	→ " "		
Mio	Cedar Mts	Nevada	3
Plio	Esmeralda beds	"	1
Pleisto	Gypsum Cave	"	1
"	Smith Creek Cave	"	3 recorded Mus?
Eo.	Homestown	N. Jer.	7
Eo.	Squankum	"	1
Eo.	Arneytown	"	1
"	near Burlington	"	1
Mio		"	1
Pleisto	Monmouth Co	"	3
"	Homestown	"	1
Plio-Mio	Pojaque	N. Mex	1
Eo.	Wasatch	"	1 Diatryma
Quat	Shelter Cave	"	53
"	Carlsbad	"	27
"	30 forks of 3 forks	"	1


species 373
genus
family
assemin ft point
St Mary's Cal.
Contra Costa Co.
Cam Obis.
Diatoma feathers?
Fontinalis "
up. Oligocene eagle
Mariposana
300
75
11
111
3 5 2
10 inserta sedis
362

Lambert Wt 1933 p. 920

Linking forms

Palaeocrex fax — between Rallidae & Megalornithidae
Paarallus " Rallus & Gallinulla
Miorallus " Gallinula & Fulica
Nesotrochas " flightless & flying rails
Aptornis " " Porphyrio & Gallinula & rails & grues

Rhynchaëtes — " Limicolae & Rallidae
Miosula — " Sula & Phalacrocorax
Cleptornis — binding the primitive Steganopodes
Cyphornis — Pelecanidae with Sulidae
? Palaeochenoides — Phalacr. & Anhingidae

Prophaethon — ?
Stromenia — ancestor of all aëpyornithids
Pelagornis — bet. Sula & Phaëthon & Fregatidae
Presbyornis — anc. of Recurvirostra & Himantopus
Palaeospiza — binds Mesitornithidae with Oscines
Hydromis — " anseres with Tubinares

Tertiary birds

1942
Miller and DeMay

Miocene Lompoc. 6 spp.
Shaktoolik Hill 3 spp.
Calabasas 1 sp.
Lomita 2 sp (one, named)
San Pedro (1 sp. synonymous w/ Lompoc)
Barstow (1 sp. not named)

Since 1942
Leisure World 5 sp. 1968
added 4 Shaktoolik Hill 1966
Studio City 1 19_
Tapiquet Canyon 2 195_?
Pyramid Hill 1 196_
Barstow 2 195_
Vasquez Canyon 1 ?
Niguel to be pub 1977

Pliocene 3rd St. Tunnel 1 sp.
Sta Barbara 1 sp
San Diego 2 sp
Sweetwater Canyon 1 sp
Kern River 2 sp (one, named)
Kern Co. oil well 1 sp.
Ricardo 1 sp.
Morago Valley Tracks only

19

Capistrano Beach 1
Corona del Mar 2 (1 new)
add 9 San Diego
Black Hawk Ranch 1

30

Sulidae spp.

The following specimens are given only family designation

Tarsometatarsi 32428 loc. 6906 prox mid
42657 loc 7134 prox
32437 loc 6906 dist

Radius 58551 loc. 6902 prox frag

Tibiotarsus 57834 " 6902 dist 2/3

The proximal tarsometatarsi measure 12.7 and 12.8 mm in prox. breadth in contrast to 14.4 in M. bassanus. The distal specimen has a breadth across the trochleae of 17.6 mm. (17.7 in M. bassanus). Proximal breadth of this element can be estimated on two specimens of M. dimorphanus, one at 12.8 mm, the other 13.8. The same dimension in Miocene Distal br. in one specimen of M. dimorphanus is 16.3, in Miocene media 17.6.

The prox tarsometatarsi seemingly represent a smaller species than the distal specimen of the same element. They seem to conform with this element of M. dimorphanus. The distal specimen agrees in breadth with a mold of the tarsometatarsus in the type of Miocene media.

The tibiotarsus is similar in character to that assigned to M. dimorphanus (above) but is slightly smaller.

The radius is Two poorly preserved fragments for measurement except for the shaft (58.9 mm) which agrees in size with M. bassanus.

When numbers appear in ○ or □ or △ these nos. refer to Nuscane species recorded from different geol. periods, ∴ correct discrepancies in totals

Fossil birds of North America

1956

red = Calif.

(144 from Calif.) 194 as of 6.9.58

	Total	living	Extinct	Cretaceous?	Pal Eocene Ext.	Pal Eocene living	Eocene 29 Ext.	Eocene 29 living	Oligo 24 Ext	Oligo 24 living	Miocene 50 Ext	Miocene 50 living	Pliocene 59 Ext	Pliocene 59 living	Pleisto 254 Ext	Pleisto 254 living	"Quaternary" Ext	"Quaternary" living	Sub Recent LTT Ext	Sub Recent LTT living	Total Calif. fossil species 6.9.58
Odontopterygiformes											1										
Hesperornithiformes	6		6	6																	
Ichthyornithiformes	8		8	8																	
Caenagnathiformes	1		1	1																	
Gaviiformes	6	2	4						1				2 3		2 2						4
Colymbiformes	8	4	4						1				□ 2 □	1	2 □ 2 □	3 4 ①					6
Procellariiformes	11	4	7								3 4		2 3			4 4					9
Pelecaniformes	30	5	25		2				3		6 9		2 8	1	2 3	4 5 ①					15 + 1 undescribed
Ciconiiformes	23	13	10				2				1		4 ①		3 4 ①	7 13					12
Anseriformes	48	29	19				1				1 5		1 7 □ ①	1 △	14 4 □ ④	28 △					22
Falconiformes	69	22	47				1		6		1 11		1 6		15 18 □	17 22 ①	3 □	①	3		34
Galliformes (2 ext age?)	37	9	28				2		2		1 10		3 □	1	2 10 □	4 9 ①					7
Gruiformes	42	10	32		3		10		7		1		1 4	④	6	4 10 ④			1		5
Dichrurniformes	5		5				5														—
Charadriiformes	54	22	32		3		4		3		2 7		3 9		5	14 22			1		20
Columbiformes	5	3	2												1	3 3			1		3
Psittaciformes	4	2	2								1					2			1		—
Cuculiformes	2	1	1												1	1					1
Strigiformes	24	14	10				4				1		1		2 2	9 4			=		12
Caprimulgiformes	1	1	—													1					—
Piciformes	4	4	—													3 4					3
Passeriformes	51	44	7						1				1		3 3	36 44	1		1		40

194